1 Substantive complexity

1. Introduction

The aim of this chapter is to demonstrate that one of the crucial organising properties of phonological representation at the melodic level is sub-segmental complexity, which is of a scalar character. Substantive complexity, as we will call it, will be shown to play a pivotal role in phonological systems, contributing to the understanding of certain static aspects of these systems, for example, segmental inventories, phonotactics, typology, markedness effects etc., as well as a number of dynamic characteristics such as phonological processing, in both its synchronic and historical dimension. It will also be shown that given a particular model of melodic representation, it is possible to simplify the nature of operations occurring at the intersection of phonology and morphology.

The chapter is organised in the following way. First, in section 2, the Element Theory is introduced and illustrated by focusing on both simple and more complex aspects of sub-segmental representation, and by showing that complexity may successfully replace such concepts as sonority, and strength in all the areas of phonological theory where they were used to account for phonological systems, including the syllabification of consonants (section 3). Then, in section 4, we look more deeply at the system of modern Irish with a view to illustrating how the model can be practically applied to a range of phenomena within one phonological system. First, we deal with vowel quality alternations and show the advantages of a privative model over an equipollent one in capturing the existing alternations, as well as capturing the peculiar pattern whereby the relative regularity of the phenomenon is strictly dependent on the height distinctions of the target vowels. The second aspect of the phonological system of Irish which is dealt with concerns the role of substantive complexity in determining grammatical coda-onset contacts. Here, a modification of the model will be proposed, which allows us to understand the Irish phonotactics better and additionally has far-reaching consequences for the types of segments that this phonological system may theoretically employ. Some systemic distinctions leading to typological variation between consonantal systems will be proposed, of which the distinction involving internal complexity seems to be the most important. Finally, we focus our discussion on the phenomenon of initial consonant mutations in Welsh with a view to showing
how this seemingly complex phenomenon can receive a fairly simple analysis within the Element Theory. This is particularly advantageous in view of the fact that the mutations are seen to no longer be purely phonological, but rather morphophonological. Thus, the model points to the possibility of simplifying the nature of the interaction between phonology and morphology.

2. The Element Theory in Government Phonology

The smallest units of phonological representation in Government Phonology are called elements. The term has been chosen not only to oppose this construct to the traditional features, but also to convey the similarity of their behaviour to physical elements, in that they can occur in isolation – simplex structures, or in compounds – complex structures. In a nutshell, the elements can be characterised as privative, cognitive units which enjoy a stand-alone phonetic interpretability. Privativeness, as opposed to equipollence, means that each relevant property of melodic representation is defined by the physical presence of a given prime, and phonological processes may refer only to actively present elements, rather than to their absence, or to a negative value for them. The term ‘cognitive unit’ is used to convey the fact that elements which encode lexical contrasts are neither articulatory nor auditory in nature.

“...continuing the essentially Jakobsonian line of thinking, we consider their phonetic implementation as involving in the first instance a mapping onto sound patterns in the acoustic signal. Viewed in these terms, articulation and perception are parasitic on this mapping relation. That is, elements are internally represented templates by reference to which listeners decode auditory input and speakers orchestrate and monitor their articulations.”

Harris and Lindsey (1995: 50)

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2 See, for example, Coleman (1998) for a review of various arguments concerning the nature of linguistic primes, in which he arrives at similar conclusions.
As far as autonomous interpretability is concerned, it is assumed that each element that is linked to a skeletal position can be directly realised as a speech sound, either alone, or in combination with other elements. The phonological representations remain privative and redundancy-free throughout the derivation. There is no place for any default fill-in procedures. For example, sonorants are non-specified for voice lexically, and they remain so at every stage of the derivation. Thus, there is no need for a level of systematic phonetic representation (Harris and Lindsey 1993, 1995: 46).

The details of the Element Theory will transpire as we proceed. Let us first look at an exhaustive list of what we assume to be a standard set of elements used in GP. The following table defines the elements in terms of their acoustic patterns and the necessary articulatory execution required in their production (adapted from Harris 1996: 314).

(1)

<table>
<thead>
<tr>
<th>Acoustic pattern</th>
<th>Articulatory execution</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Mass: central spectral</td>
<td>Maximal expansion of oral tube; maximal constriction of</td>
</tr>
<tr>
<td>energy mass (convergence</td>
<td>pharyngeal tube</td>
</tr>
<tr>
<td>of F1 and F2)</td>
<td></td>
</tr>
<tr>
<td>I Dip: low F1 coupled with</td>
<td>Maximal constriction of oral tube; maximal expansion of</td>
</tr>
<tr>
<td>high spectral peak</td>
<td>pharyngeal tube</td>
</tr>
<tr>
<td>(convergence of F2 and</td>
<td></td>
</tr>
<tr>
<td>F3)</td>
<td></td>
</tr>
<tr>
<td>U Rump: low spectral</td>
<td>Trade-off between expansion of oral and pharyngeal tubes</td>
</tr>
<tr>
<td>peak (convergence of F1</td>
<td></td>
</tr>
<tr>
<td>and F2)</td>
<td></td>
</tr>
<tr>
<td>? Edge: abrupt and</td>
<td>Occlusion in oral cavity</td>
</tr>
<tr>
<td>sustained drop in overall</td>
<td></td>
</tr>
<tr>
<td>amplitude</td>
<td></td>
</tr>
<tr>
<td>h Noise: aperiodic energy</td>
<td>Narrowed stricture producing turbulent airflow</td>
</tr>
<tr>
<td>N Nasal: low frequency of</td>
<td>Lowered velum; air flow through the nasal passage</td>
</tr>
<tr>
<td>first resonance</td>
<td></td>
</tr>
<tr>
<td>H High tone: raised pitch</td>
<td>Stiff vocal cords</td>
</tr>
<tr>
<td>on vowels; VOT lag</td>
<td></td>
</tr>
<tr>
<td>(aspiration) in obstruents</td>
<td></td>
</tr>
<tr>
<td>L Low tone: lowered pitch</td>
<td>Slack vocal cords</td>
</tr>
<tr>
<td>on vowels; VOT lead</td>
<td></td>
</tr>
<tr>
<td>(full voicing) in</td>
<td></td>
</tr>
<tr>
<td>obstruents</td>
<td></td>
</tr>
</tbody>
</table>

3 The modal voicing of sonorants in the Element Theory may be said to follow from the fact that they are typically represented by the same primes as vowels, that is, resonance elements, to be introduced below. Most sonorants exhibit spectral patterns similar to vowels.
Before we continue the discussion, it must be emphasised that the rough universal cues inherent in the elements listed above become fully meaningful only when they are viewed as part of a particular sound system. As we will see presently, it may be the case that a given phonological representation will not correspond to identical phonetic interpretations across languages. Here we differ markedly from Kaye, Lowenstamm and Vergnaud (1990: 194) who assume that “the same physical object will receive uniform interpretation across phonological systems”. Since they made their proposal it has been found that the same representation will not always yield identical phonetic effect or vice versa. That is, identical phonetic objects may have disparate phonological representations across systems.

2.1. Representing vowels

The first three elements (A), (I), and (U) in (1) define vocalic expressions and place of articulation in consonants. The discussion of vowel systems within the Element Theory will serve the purpose of a rather sketchy illustration of some of the points made above. However, in general, more emphasis will be placed on consonantal systems in this work.4

A basic three-vowel system, for example [a,i,u], reflects simplex representations involving only one element in each case (2a). These are the least marked vowels which utilise the phonetic vowel space most efficiently. We may define this space either in terms of articulation, using familiar properties like HIGH, LOW, BACK, FRONT, or in terms of acoustic dimensions.5 At any rate, the simplex character of the three corner vowels reflects their universally unmarked status (Crothers 1978, Maddieson 1984). The schwa vowel represents the neutral state of articulators and, typically, evenly spaced-out formants (e.g. Johnson 1997). In Government Phonology this vowel may be viewed as a realisation of a neutral element or nothing, a point which will be returned to when we discuss headedness.

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5 See, for example, Ladefoged (2001: 39ff) for a discussion of how, with a certain amount of theoretical gymnastics, the same phonetic space can be defined in terms of F1 and F2 values.
Other vowels are combinations of the elements (I), (A), (U), for example, (A-I) = [ɛ], (A-U) = [ɔ], (I-U) = [ü] (2b). It follows from the illustrations in (2) that the more complex and marked vowel systems have more complex representations in terms of combinations of elements. Thus, the relation between markedness and representational complexity is inherent to the model.

The relative markedness of mid vowels is reflected in the fact that they are the first vowels to be eliminated in prosodically weak positions. Let us look at some typically quoted instances of vowel reduction in unstressed positions (Harris and Lindsey 1995).

Note that in both languages the surviving melodies in unstressed positions are simplex. We do not wish to make any particular claims concerning the representation of schwa vowels in the two systems, that is, whether they still contain the element (A). However, one thing is clear, compound structures cannot be maintained in prosodically weak positions.

We must note two immediate advantages of the Element Theory in the description of vowel reduction. Firstly, the relative markedness is directly read-off from the representations rather than extrinsically encoded on the basis of observation. Secondly, there is a direct and logical connection between vowel reduction and the context where it occurs. Prosodically weak positions simply eschew complex vocalic structures, therefore, the latter must be reduced in
complexity. At this point, one more aspect of representations in the Element Theory must be introduced which will clarify the status of schwa and answer the question of how to define vocalic systems with more than six or seven vowels. This additional mechanism is called headedness.

When two elements combine to form a compound, for example, (A-I), it is assumed that the elements may enter into an asymmetrical relation in which one of the elements may dominate the other, thus yielding a different object than if the situation was reversed. Roughly speaking (A.I) would correspond to phonetic [e], while (A.I) should give [æ]. In other words, due to the reversed head-operator relations, we are dealing with an essentially high front vowel which is lowered, and an essentially low vowel which is fronted and raised, respectively. However, the use of headedness has been extended to two other situations. One of them concerns simplex structures. Here we find two different representations, that is, a headed simplex structure, and a headless one. Thus, headed (I) expresses tense [i], while headless (I_) denotes lax [i]. Similarly, a compound as a whole may also be headless, for example, (A.I_). This structure corresponds to the open front mid vowel [ɛ]. Thus, the introduction of headedness accounts for tense/lax contrasts, and introduces greater generative potential into the simple theoretical system which uses only three basic elements to define vowel systems. Note that now we are able to define much richer systems, and the contrast between, for example, [e] and [ɛ] which we saw earlier in the system of Catalan (3), presents no theoretical problem. In fact, the introduction of headedness allows the model to define at most twenty vocalic objects, and attempts have been made to restrict the generative power of the Element Theory even further (e.g. Charette and Göksel 1996, 1998, Backley 1995, 1998, Cobb 1993, 1997, Kaye 2001).

As for schwa vowels, there are various options to consider. It is not impossible that some schwas do have an active resonance element in operator position, for example, (A_), (U_), (I_). This would account for the various qualities of schwa vowels, not only across languages but also within one system,

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6 A more detailed study would be required to determine the behaviour of the element (A) in the two languages.
7 This idea is familiar from such models as Dependency Phonology (e.g. Anderson and Ewen 1987).
8 Throughout this work the elements will be used in parentheses and underlined when headed, unless headedness is irrelevant for the discussion. Compounds in which head specifications are deliberately omitted will be represented as e.g. (A-I).
9 One must add that apart from the three resonance elements, (L), (H), and (N) may also be used in vowels. They represent tonal patterns – low and high pitch – and nasalisation respectively.
for example, English. Within the Element Theory, it has also been proposed that there is an additional element, the neutral element (@) which is present in all representations but only shows up if the full-blooded elements are absent (Harris and Lindsey 1995). Other proposals boil down to the assumption that schwa may have no representation in terms of elements, that is, phonologically speaking it is a phonetically interpreted nuclear position which has no melodic content. Under this proposal, the difference between schwa and an empty nucleus proper lies only in the fact that the former is interpreted phonetically and the latter remains silent.\footnote{More on empty nuclei can be found in the following chapters.} Let us see how these options may be applied to the well-known phenomenon of the rise and fall of jers in Slavic.

\begin{align}
[u] & \rightarrow [\varepsilon] \rightarrow [\emptyset] \\
[i] & \rightarrow [\epsilon] 
\end{align}

Generally speaking the short high back and front vowels [u] and [i] were weakened to the so called jers [ɛ] and [ε], which were later lost in particular positions.\footnote{The development of jers will be discussed at length in chapter 3.} Given the current assumptions of Element Theory, we may provide three descriptions of the events depending on our view on the structure of schwa and the status of the neutral element.

\begin{align}
[u/i] & \rightarrow [\varepsilon/\epsilon] \rightarrow [\emptyset] \\
a. \ (U/I) & \rightarrow (@) \rightarrow (\_)
\\nb. \ (U/I) & \rightarrow (U/I\_\_) \rightarrow (\_)
\\nc. \ (U/I) & \rightarrow (\_\_) \rightarrow (\_)
\end{align}

All three options agree in their interpretation of the last stage in which there is no melody left in the nucleus. In (5a), the rise of jers is accompanied by the complete loss of the melodies (U) and (I). What remains in the representation is the neutral element, while the opposition between back and front jers must be assumed to have been shifted onto the preceding consonant. The interpretation in (5b) assumes that the jers are schwa-like but they still contain the resonance elements as operators, and only when these elements are lost is a phonetic zero
possible. Under this view, only after the loss of jers was palatalisation represented on consonants. The last view, represented in (5c), is similar to (5a) in assuming that jers have no active resonance elements and that the putative opposition should be represented on consonants: palatalisation vs. velarisation or nothing. However, it assumes that schwas and schwa-like vowels may be representationally identical to empty nuclei. The difference lies in the context-based interpretation of such constructs.

In this work, we will follow the assumption that there is no such thing as a neutral element, which narrows down the options in (5) to two. However, the problem of the phonological structure of schwa, or of the jers, cannot be dismissed with one sweeping statement. More detailed discussion of these objects will be provided in the relevant contexts in the following chapters. An example of an element-based analysis of a vocalic system will be provided in section (4.1.). Let us now turn to the representation of consonants in the Element Theory.

2.2. Representing consonants

In the previous section we saw how vowels are represented in the Element Theory and how a phonological representation may be affected in phonological processing. Vowel reduction, for example, is a phenomenon in which the internal structure of a vowel is decomplexified by means of deducing primes, e.g. (A-I) > (I), or reducing their status from head to operator, e.g. (A) > (A_). Both cases are instances of weakening and their direct contextual linking to weak prosodic positions is a welcome effect. Besides decomposition, the Element Theory also predicts composition as another possible type of phonological event. This process involves element addition, as in vowel harmony or the strengthening of consonants. In both instances a condition must be satisfied whereby the added element is locally present. Let us now look in more detail at the representation of consonants in the Element Theory.

12 This is probably too general a statement. Some historical processes of consonant strengthening, for example, [w] > [v] in the history of Slavic languages, require a more complicated, and less idealised analysis (Cyran and Nilsson 1998). In a nutshell, since the weakening processes involve either element deduction or demotion, it is logical that strengthening may involve element addition or promotion to headed status. Cyran and Nilsson claim that in Slavic strengthening in which there is no source for the added elements, two stages are necessary: first element promotion, e.g. (U) > (U), yielding [w~v] alternations, and then phonological reanalysis of (U) as (U,h,L), yielding systems with [v~f] alternations. Mixtures of the two systems are also possible, e.g. in Slovak (Rubach 1993: 244ff).
2.2.1. Place
The resonance elements discussed above define primary and secondary places of articulation in consonants.

(6) (I) = palatal, e.g. [j, ç, ĝ]  
palatalised, e.g. [p’, k’]  

(U) = labial, e.g. [p, b, v, f, w]  
labialised, e.g. [k”, g”]  

(A) = coronal, e.g. [r, t, s]  
retracted (uvular, pharyngeal), e.g. [R, q, G, ñ]  

( _) = velar, e.g. [k, g, x]  
velarisation, e.g. dark [t] in English  

The categories given in (6) must be taken as rough indications rather than exact representations. It will transpire presently that the best way to talk about the Element Theory is within the context of a particular system. The parsimony of the model must be striking for anyone familiar with the IPA chart. However, it is also true that no language uses all the place, or indeed manner distinctions found in the world’s languages. Thus, it must be borne in mind that the actual representations of consonants in a given system must follow an in-depth analysis and should not be assumed a priori.

Before we consider the manner and source elements, let us briefly look at an illustration of how primary and secondary articulations as defined by resonance elements may interact in the description of certain historical shifts in consonant place of articulation.

In Celtic languages there was regular labialisation of Indo-European *g” to [b] as in, for example, IE *g”ou-, ‘cow, ox’ > Old Irish bó, Welsh bu, or IE *g”enä, ‘woman’ > Old Irish ben, Welsh benyw. A similar phenomenon affected the proto-Celtic voiceless labialised velar *k”, but only in the Brittonic subgroup, thus leading to the linguistic division into the so called P– and Q–Celtic groups.  

(7) *k”eturos  
p (Brittonic)  
pedwar  
*pwy  
*mak”k”o-  

*kn”  
k (Goidelic)  
cethar  
cia  
macc  
‘four’  
‘who’  
‘son’  

---

13 This shift also occurred in other IE languages, e.g. Italic (Oscan and Umbrian *k” > p), and to some extent in Greek.
Given that the representation of velars has no active element, the secondary labialisation is best represented as the presence of the (U) element in operator position. The shift from [gʷ] to [b] in Celtic in general, or [kʷ] to [p/b] in Brittonic, is thus directly captured as a switch in the status of the resonance element from operator to head.\(^{14}\) For the moment we ignore the other elements making up the velar plosive and concentrate on place only.

\[(8)\]

<table>
<thead>
<tr>
<th>velar</th>
<th>labialised velar</th>
<th>labial</th>
</tr>
</thead>
<tbody>
<tr>
<td>[g]</td>
<td>[gʷ]</td>
<td>[b]</td>
</tr>
<tr>
<td>(_)</td>
<td>(U._)</td>
<td>(U)</td>
</tr>
</tbody>
</table>

The distinction between the three types of segments can be described as a scale of (U) presence. While it is completely absent in plain velars, it affects the labialised consonants as an operator – adds the labial colouring as it were, or, in the case of the labial, it assumes the head position. Thus, one way to distinguish between primary and secondary articulation of consonants is by referring to the status of the resonance element.\(^{15}\)

A similar description can be offered for parallel shifts in Slavic. This time the property that affects a velar consonant is (I), responsible for palatalisation. In Polish, there are two types of palatalisation of velars which merit a synchronic phonological analysis: surface velar palatalisation and the so called 1\(^{st}\) velar palatalisation (e.g. Gussmann 1978, 1980, Rubach 1981).\(^{16}\) In the former, the velar plosives [k, g] and the fricative [x] are phonetically palatalised to [k´, g´, x´], while in the latter the three velar obstruents are turned into palatal [tʃ, ʒ, ʃ]. The two types of palatalisation may be given a similar interpretation to the one involving the different degrees of labialisation in Celtic.

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\(^{14}\) The [p/b] variation in Welsh is due to lenition which is discussed in some detail in section (5.) below.

\(^{15}\) Another possibility that may be considered for the purpose of capturing secondary articulation is connected with structural distinctions, for example, the use of contour structures.

\(^{16}\) See Gussmann (1978) for arguments that the so called 2\(^{nd}\) velar palatalisation, turning [k, g, x] to [ś, ǳ, ʃ] respectively, as in rzeka – rzece ‘river, nom.sg./loc.sg.’, noga – nodze ‘leg, nom.sg./loc.sg.’, mucha – musze ‘fly, nom.sg./loc.sg.’, has no synchronic reality as a phonological regularity.
Here too, the plain velar may be devoid of any secondary articulation, or may be affected by the element (I) in two ways: as operator or head. The switch to head status of the resonance element produces a palatal consonant which concomitantly undergoes affrication.\(^\text{17}\) Note that this is only a possible analysis and is defined only in terms of interacting place elements. A full analysis of these phenomena in Polish requires much more detailed and comprehensive discussion which would, for example, deal with such puzzles as the behaviour of the voiced velar stop, which in the 1st velar palatalisation does not yield the expected voiced palatal affricate, parallel to \([k] > [t\dagger]\), but rather a fricative \([\mathbf{3}]\), parallel to \([x] > [\mathbf{f}]\). The only cases where the expected object appears involve clusters, as in \(\text{mózg} – \text{móźdżek} [\text{muźdžek}] \text{‘brain / dim.’}\). We are unable to answer this question here, though admittedly, a successful analysis of this problem would effectively prove the superiority of non-derivational models to derivational ones, as such facts from Polish phonology have served as arguments in favour of rule ordering and intermediate stages in derivation (e.g. Gussmann 1978, Rubach 1981).

Let us now turn to the remaining elements defining other dimensions in the representations of consonants.

### 2.2.2. Manner

The manner dimension in consonants is defined by five elements of which only two (\(\varnothing, h\)) can be called truly consonantal. As mentioned above, nasality, as well as high and low tones are also used in vowel systems. The latter two will be discussed in more detail in the following sub-section.

\(^{17}\) Some phonological reasons for this affrication, couched in terms of the Element Theory, are provided in, e.g. Cyran (1997: 214). Note also that we are discussing major functional distinctions \(\text{velar} – \text{palatalised velar} – \text{palatal}\), and not the exact phonetic articulation.
Each of the elements above deserves comment. The occlusion element is also assumed by some researchers to be present in nasal consonants and laterals (Kaye, Lowenstamm and Vergnaud 1985, Harris 1990). The noise element is assumed to be present in all released stops. The status of nasality as an independent prime has been challenged in the work of Nasukawa (1998, 2000) and Ploch (1999). Both researchers attempt to merge nasality with low tone (L) in some way.

Leaving aside the laryngeal elements for the moment, let us observe how some basic consonants may be represented by means of the three manner elements just mentioned. The representations below only serve the purpose of illustrating how the Element Theory captures such phenomena as lenition.

\[ \begin{align*}
(p) & = \textit{occluded}, \text{ e.g. } [p, t, k] \\
(h) & = \textit{\'noisy'}, \text{ e.g. } [s, f, x] \\
(N) & = \textit{nasal}, \text{ e.g. } [n, m, n] \\
(H) & = \textit{voiceless aspirated } [p^h, t^h] \\
(L) & = \textit{fully voiced } [b, d, g] \\
\end{align*} \]

\[ \textbf{(10)} \]

\[ \textbf{(11)} \quad \textit{lenition trajectory of the opening type} \]

\[
\begin{array}{c}
[p] > [f] > [w] > [\emptyset] \\
U \quad U \quad U \\
h \quad h \\
? \\
\end{array}
\]

---

\[ \text{\textsuperscript{18}} \text{ This view is challenged in Cyran (1996a) who proposes that the noise element may in some systems be completely missing even in released stops. We will return to this idea shortly in the discussion of Irish clustering and Welsh consonant mutations.} \]

\[ \text{\textsuperscript{19}} \text{ This discussion of lenition draws heavily on the work of Harris (1990, 1996, 1997) and Harris and Lindsey (1993, 1995). Note that so far we limit ourselves to a discussion of the effects produced on a given segment, and little reference is made to the link between lenition phenomena and the contexts in which they occur. The typical sites for lenition or neutralisation can be roughly defined as the intervocalic and coda positions. The latter context is understood in a dramatically different way in Government Phonology than in other current frameworks (see e.g. Kaye 1990, Harris and Guussmann 1998).} \]
Since each element on its own and each possible combination of elements can be independently interpreted in production and perception, each of the stages along the trajectory can be described as the effect of losing one phonological prime, that is, decomposition. Thus there is a logical connection between the fact that lenition is a weakening process and the idea that decomposition leads to progressively less complex structures. Recall that vowel reduction in unstressed position consists in precisely the same procedures though, admittedly, the contexts for consonantal lenition are different from those for vowel reduction. Nevertheless, we can describe both contexts uniformly as prosodically weak (Harris 1997).

It is obvious now that sonority is the inverse of sub-segmental complexity, though it seems that the complexity scale captures the lenition trajectory better. First of all, as noted by Harris (1996), if the sonority hierarchy is anything to go by then we should expect nasals to appear along the lenition trajectories of obstruents as they are more sonorous than, say, [p] or [f]. Secondly, it seems that complexity is able to solve two apparent paradoxes connected with the weakening of consonants and vowels. The first one concerns the fact that in terms of sonority the weakening of vowels, such as the rise and fall of jers in Slavic discussed above ([u/i]>[и/и]>[φ]), results in less and less sonorous objects, in contradistinction to the weakening of consonants which results in more and more sonorous ones. Secondly, the sonorisation of consonants ends with a stage where the object is the least sonorous one, that is silence ([p]>[f]>[w]>[φ]). In terms of complexity, both phenomena receive a uniform interpretation. Simply, all stages of vowel weakening and consonant lenition are of the same nature: depletion of melodic complexity.

The element-based analysis of lenition also bypasses the pertinent problem of major class feature changes. In this model, what remains as the outcome of any decomposition process is as interpretable as the previous stage, as shown in (11) above. There are two more points to be made here. Firstly, in the model of representations introduced in this section the range of possible processes that a given segment may undergo is logically limited by its phonological structure. For example, a stop may either lose its release (h), be spirantised by losing (?), debuccalised by losing the resonance element defining place, voiced or

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20 I was made aware by Péter Szigetvári (p.c.) that the last point may be erroneous, in that that net result of the last stage in the lenition trajectory is the most sonorous stage, because what is left is the vocalic context flanking the consonantal position. Though essentially true, this point does not diminish the merits of the complexity-based treatment of lenition in any way.

21 For a critical evaluation of various proposals to deal with this issue see Harris (1990).
devoiced. Secondly, the pre-deletion stages typically involve a simplex segment, for example, \([h]=\text{h}\), \([?]=?\), as well as \([w]=\text{U}\), \([j]=\text{I}\), and \([r]=\text{A}\), while their sonority values differ markedly (Harris 1994: 122).

In general, it appears that complexity can quite successfully replace sonority in lenition, and it is the inverse of sonority. On the other hand, complexity seems to go hand in hand with another term used with relation to lenition, and indeed syllabification, namely, strength. In our model, the plosive seems to be the most complex and at the same time the strongest consonant. This direct relation between complexity and strength follows from the internal representation rather than being assumed in an arbitrary fashion on the basis of observation. In the following sections and chapters it will be shown how strength defined as complexity is exploited in syllabification. In the meantime, let us deal with the last two elements, which define the laryngeal distinctions.

### 2.2.3. Source

The Element Theory uses only two elements to express all the possible phonation types: (L) which is found in fully voiced obstruents, and (H) which is found in voiceless fortis obstruents. It is assumed that laryngeal specification is typically asymmetrical. For example, in a system like English, which exhibits voiceless aspirated stops as opposed to weakly voiced ones, the opposition is expressed by marking the fortis series with the high tone element (H), while the so called lenis series bears no laryngeal element. In other words, the lenis obstruents are neutral. On the other hand, languages like Polish in which the opposition among the obstruents is that of fully voiced as opposed to voiceless, it is assumed that the voiced series is the marked one and contains the low tone element (L), while the voiceless series is unspecified. It follows then that from the phonological point of view, the same phonological representation of, for example, neutral stops, yields quite different phonetic results in Polish and in English. However, we must remember that the respective interpretations belong to two distinct systems in which the neutral stop is perceived and produced with sufficient phonetic difference from the series to which it is opposed. If the marked series is fully voiced, as in Polish, then the neutral series tends towards the voiceless reflex, and conversely, if the opposite series is voiceless then the

---

22 The concept of strength has a long history in phonological theory. It typically refers to inherent properties of segments which determine their behaviour in lenition processes as well as phonotactics (e.g. Sievers 1901, Vennemann 1972, Hooper 1976, Foley 1977, Murray 1988).
neutral series tilts towards the voiced one. A simple acoustic analysis of English and Polish plosives reveals that the supposedly distinct neutral series are very similar, thus supporting our views on how the opposition should be represented.

One of the ways to define laryngeal distinctions in phonetics is by means of Voice Onset Time, that is, VOT (Lisker and Abramson 1964). This is the interval between the release of a stop and the start of a following vowel. In general, the neutral obstruents in English have a short VOT and a little voicing occurring before the release, to which we may refer as VOT lead. The fortis series has a long VOT, also called VOT lag (e.g. Harris 1994, Ladefoged 2001). On the other hand, the neutral series in Polish and Spanish have a short VOT in the voiceless series, as opposed to distinct voicing during closure, that is, a long VOT lead in the voiced series. The Element Theory assigns elemental representations to the long VOT lead (L), and the long VOT lag (H), but no element defines the short VOT type. The typology of phonation types in obstruents supports the view that the short VOT class is the unmarked one. For example, if a system has only one series of stops it is typically voiceless unaspirated, that is, having short VOT, or, in terms of elements, no laryngeal specification.24 The majority of languages exhibit the two-way distinction of the two main types: fully voiced vs. plain voiceless, and voiceless aspirated vs. voiced. Let us look at a simple typology of laryngeal distinctions and see how the element theory can capture the VOT distinctions. The typology is based on Harris (1994), Ladefoged (2001) and Maddieson (1984). The unmarked series of stops, with short VOT, and their elemental representation are represented as ‘_’, that is nothing.

\[
\begin{array}{|c|c|c|}
\hline
\text{language} & \text{VOT opposition} & \text{representation} & \text{examples} \\
\hline
\text{Malakmalak} & \_ & (\_) & p \\
\text{Spanish} & \text{lead} & \_ & (L), (\_), b, p \\
\text{English} & \_ & \text{lag} & (\_), (H), b, p^h \\
\text{Thai} & \text{lead} & \_ & \text{lag} & (L), (\_), (H), b, p, p^h \\
\text{Hindi} & \text{lead} & \_ & \text{lag, lead/lag} & (L), (\_), (H), (LH), b, p, p^h, b^f \\
\hline
\end{array}
\]

23 The term phonetic polarisation may be used to describe this effect. This is reminiscent of the Dispersion Theory (Liljencrants and Lindblom 1972), which has recently been harnessed into Optimality Theory in the form of SPACE constraints (e.g. Flemming 1995, Ní Chiosáin and Padgett 2001).
24 In fact 98% of such systems in the UPSID data base show this tendency (Maddieson 1984: 28).
It seems that both the VOT and the element system share the ability to capture one important aspect of the above typology, namely, that with the increase of the number of contrasts, the number of VOT combinations and the complexity of representations in terms of elements also increase.\(^{25}\) Thus, once again the relative markedness of particular systems goes hand in hand with the relative complexity of representations. Both models of description have a neutral series in each system of oppositions, and they seem to be able to directly express laryngeal neutralisations in a straightforward fashion: as the simplification of laryngeal activity, giving rise to the unmarked variant. This advantage of privative models over equipollent ones is well-established in phonological theory (e.g. Lombardi 1995).

Let us look at how the phenomenon of obstruent devoicing is captured in Government Phonology. As mentioned above, in Polish the voiced series of obstruents is marked and bears the element (L), while the voiceless obstruents have no specification.\(^{26}\)

\[
\begin{array}{cccccccc}
U & U & A & A & _ & _ & U & U \\
h & h & h & h & h & h & h & h \\
L & L & L & L & L & L & L & L
\end{array}
\]

In an asymmetrical system of privative specification of voice, devoicing is understood as delinking of the property responsible for voice due to licensing failure in prosodically weak positions. Again, there is a direct relation between the structural description of the phenomenon and the fact that we are dealing with neutralisation, or weakening. We do not attempt a full analysis of devoicing in Polish here, suffice it to say that predominantly it is due to the weak licensing that the obstruent receives in a particular context, for example, word-finally, that is, before an empty nucleus.\(^{27}\)

\(^{25}\) For a more advanced discussion of the relation between the Element Theory and VOT types see Harris (1994: 133).

\(^{26}\) For a discussion of the relationship between tone and voice see, e.g. Matisoff (1973).

\(^{27}\) An exhaustive and satisfactory analysis of all the voice phenomena in Polish within the Element Theory has not been proposed yet. For surveys of all the relevant issues and recent analyses see Gussmann (1992) and Rubach (1996).
It appears then that Polish and English have quite different complexity asymmetries in the representation of their obstruents. In the following section we will look at one possible indication in the phonotactics of the two languages which might directly fall out from the different laryngeal specifications employed in the two systems. The example illustrates how complexity differentials play a role in understanding fragments of phonological systems. More intricate complexity effects will be described in the ensuing sections.

3. Complexity and syllabification

In the above discussion we saw how the concept of complexity is able to capture a number of segmental phenomena, successfully replacing such notions as sonority or strength. The advantage of complexity over the other two concepts is that the scales of relative complexity fall out from the internal composition of segments and, therefore, are directly incorporated into phonological processing, rather than being arbitrarily postulated as look-up scales. Syllabification and phonotactic restrictions is another area of phonology in which sonority and strength play an important role. The aim of this and the following section is to demonstrate that complexity may replace these constructs also here, and also provide some new insights into the nature of syllabification.

In definitions of well-formed branching onsets or good syllable contacts, that is, coda-onset clusters, the sonority profile plays an important role (e.g. Selkirk 1982, 1984). A good coda-onset contact is one in which the coda is more, or at least no less sonorous than the following onset (e.g. Harris 1994). In models operating with strength of segments, for example, (Vennemann 1972, 1988, Murray 1988), the preferred contacts are similarly defined as those in which the strength differential between the coda and the following onset is greater, in favour of the latter. The strength scale, however, is the inverse of sonority, therefore, the onset will be stronger, or higher on the scale of strength, and the preceding coda will be weaker. This is no place to introduce the syllabification principles of Government Phonology. Suffice it to say that in terms of phonotactics it is no different from sonority- or strength-based models, in that the best contacts are those with the greatest complexity differential. For ease of comparison with the other models, the most complex segments in the Element Theory are obstruents, that is, they are the least sonorous in the former theory and the strongest in the latter.

Much stricter conditions constrain well-formed branching onsets. Here, the condition of sufficient sonority distance is usually referred to in order to account

28 This understanding of strength will be returned to in more detail in the following chapter where we take up the problem of syllabification in Government Phonology.
Chapter 1

for the fact that onsets of the type [pl, kl], or [tr, kr] are better than [ks, pf, kn]. In fact, most of the latter group are normally viewed as impossible onsets, at least in English. Thus, the best branching onsets are those which involve an obstruent as the first element and a glide or liquid as the second. What is required then is sufficient distance in terms of sonority, strength, or complexity between the two consonants. Below, we compare a fragment of the phonotactics in English and Polish, in which the preferences seem to be contradictory. While in the sonority and strength systems this problem cannot be solved without arbitrary reshuffling of the scales, in the complexity-based model the facts fall out directly from what we know about the representation of obstruents in the two languages. Specifically, the differences will depend on the way the laryngeal contrasts are specified.

Both English and Polish have branching onsets of the type [pr, br]. However, once we move down the scale of complexity of the other labial obstruents in the two languages, it seems that there are some restrictions to the effect that while [vr] is a well-formed onset in Polish, for example, *wrota ‘gate’, wróg ‘enemy’, wrona ‘crow’, in English this option is not utilised in native vocabulary, except for the onomatopoeic *vroom, or some obsolete forms and French borrowings. On the other hand, while [fr] is a perfect branching onset in English, for example, *free, front, freak, etc., in Polish, words beginning with this cluster are mostly borrowings, for example, *fryzura ‘hair-style, frytki ‘fries’, frykatyw ‘fricative’, frustracja ‘frustration’. Admittedly, [fr] in Polish fares much better than [vr] in English, as most of the borrowings are fully integrated into the language and one might even find some forms which sound native, for example, *fruwać ‘to fly’. ²⁹

It seems that complexity as understood in the Element Theory may provide some rationale for these asymmetries between English and Polish. The representations below are limited to the relevant labial obstruents and [r], which is the second element of the branching onset.

(14)  \[
\begin{array}{cccccc}
\textbf{some English consonants} & p & b & f & v & r \\
\hline
U & U & U & \Box & U & A \\
h & h & h & h & \Box \\
H & H & L & L \\
\end{array}
\quad \begin{array}{cccccc}
\textbf{some Polish consonants} & b & p & v & f & r \\
\hline
U & U & U & \Box & A \\
h & h & h & h & h \\
L & L \\
\end{array}
\]

²⁹ The gap in native Polish vocabulary may be due to the fact that most of the modern instances of [f] are either borrowings or due to the devoicing of [v] which, however, does not take place word-initially.
Recall, that the specification of the laryngeal contrasts in English involves the presence of high tone in the voiceless obstruents, while in Polish the voiceless series is unmarked. It transpires from the representations above that [fr] in English is parallel to [vr] in Polish in terms of complexity differential, an effect which in sonority-based accounts must result from arbitrary manipulation of the scale. In both languages preference is given to the clusters with the greater complexity differential. Theoretically, neither English [vr], nor Polish [fr] are completely illegal because there is some differential, but their ‘toned’ counterparts are understandably preferred. In the following chapter the role of complexity in syllabification will be defined in more detail. It is hoped that we will be able to provide an answer to the question why clusters with identical complexity slopes (English [vr] and Polish [fr]) still show a different degree of acceptability. This will be connected with conditions on syllable structure which are of more importance than substantive constraints on well-formed onsets.

The following section discusses some complexity effects in modern Irish in which we try to demonstrate the connection between phonotactics, syllable structure, and phonological processes on the one hand, and sub-segmental representations on the other.

4. Substantive complexity effects in Irish

In this section, we bring together a few aspects of the phonological system of Irish in order to demonstrate how the element-based model is employed in concrete analyses of linguistic facts, and how various aspects of one phonological system converge in the internal representation of its consonants and vowels. Since the discussion is limited to substantive complexity effects, some aspects of the data reviewed in this section will receive a fuller interpretation once other principles of phonological organisation are introduced in the following chapters.

4.1. Features vs. elements in vocalic alternations

From the presentation of the Element Theory it follows that an element may be equal to a segment, while some segments contain more than one element. That is, given that elements are autonomously interpretable, one element is enough to produce a segment, for example, (I) defines the vowel [i]. In this respect, elements are bigger units than features. Note that in order to get the same vowel

30 One might wish to extend this analysis to another asymmetry in English, namely, [0r] vs. *[0r], or [fr] vs. *[3r].
in any feature-based model, we need at least two features, for example [+HIGH] and [–BACK], neither of which means anything in isolation, because the former defines all high, while the latter refers to all front vowels. On the face of it, it seems that feature systems are therefore able to provide more precise and subtle descriptions of phonological phenomena. The question however is if analyses in terms of elements fail to cover the empirical facts, and, more importantly, if they can account for the same phenomena better or worse than feature-based systems. Let us briefly look at a comparison of two analyses of vowel quality alternations in Irish, one couched in the equipollent version of feature specification (Ní Chiosáin 1994), and the other within the Element Theory (Cyran 1997).

In all dialects of Modern Irish consonants are grouped into two quality series: palatalised and velarised. These consonants affect the preceding phonologically short vowels by spreading their secondary articulation property. In the data below (C) refers to Connemara and (M) to Munster Irish.

(15)

a. (u ~ i) [muk] ~ [mik´] muc / muic ‘pig / dat.’ (C,M)
b. (o ~ e) [sop] ~ [sep´] sop / soip ‘wisp / gen.sg.’ (C)
c. (o ~ i) [sop] ~ [sip´] sop / soip ‘wisp / gen.sg.’ (M)
 [kod] ~ [kid´] coda / cuid ‘portion, gen.sg./nom.’ (C,M)
d. (a ~ i) [f´ar] ~ [f´ir´] fear / fir ‘man / gen.sg.’ (M)
   [f´æ:r] ~ [f´ir´] fear / fir ‘man / gen.sg.’ (C)
e. (a ~ e) [d´as] ~ [d´eʃa] deas / deise ‘nice / gen.sg.’ (M)
   [d´æ:s] ~ [d´eʃa] deas / deise ‘nice / gen.sg.’ (C)

Although the preceding onset is not unimportant, for the sake of simplicity we will limit the discussion to the context VC, in which the quality of the onset affects the nucleus to its left.

The alternation [u~i] seems to be the most regular and the effects are identical in the two dialects. The alternation [o~e] is rather limited to Connemara

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31 The distinction palatalised vs. velarised is typically represented as C’ vs. C. The consonant inventory of Irish, with a degree of simplification, is as follows: Labial (p, p’, b, b’, f, f’, v, v’, m, m’), Coronal (t, t’, d, d’, s, s’, n, n’, l, l’, r, r’), Velar (k, k’, g, g’, x, x’, y, y’, nj, nj’), Glottal (h, h’).

32 Consonants also affect the following vowels although on a smaller scale. This effect may to some extent be called phonetic. See Ní Chiosáin (1991, 1992) and Bloch-Rozmej (1998) for thorough analyses of these effects in Connemara Irish, and Cyran (1995, 1997) for the Munster dialect.
Irish, and the corresponding alternation in Munster is that of [o~i]. Nevertheless the [o~i] alternation is also found in the descriptions of western dialects, for example, in Connemara (de Bhaldraithe 1945). As for (15d), the alternation may be said to be identical in both dialects, despite the difference in the pronunciation of the stressed [a] which comes out as [æː] in Connemara. Similarly, the alternation [a~e] seems to be analogous in the two dialects. However, this alternation is highly conditioned. To obtain [e], the nucleus must be flanked by palatalised consonants on both sides, and, additionally be followed by a schwa vowel in the following nucleus.

In Ní Chiosáin (1994), the alternations illustrated above are due to spreading of the feature [±BACK] from the consonants into the nucleus. [−BACK] and [+BACK] define the palatalised and the velarised consonants respectively. Short nuclei, which are the targets of the spreading, are underspecified for backness. Ní Chiosáin proposes that the inventory of short vowels involves only three objects: two underspecified ones, that is, [I] and [E] which correspond to high and mid vowels, and a low [ɛ] which has a phonetic variant [aːɛː] after a palatalised onset (C´aːɛː). Thus, Ní Chiosáin predicts that only high and mid vowels are targets of backness spreading, while the alternations in (15d) and (15e), which involve manipulation of height, are not part of the rule Spread [BACK]. This move is, of course, logical. It is difficult to expect that spreading of [±BACK] should cause changes in height. However, the effects involving the low vowels occur in exactly the same phonological contexts as the high and mid vowel alternations, that is, when the quality of the following consonant changes from [+BACK] to [−BACK]. Thus, to capture this fact one would need to refer to backness to account for height shifts, despite the lack of formal connection between the two phonological objects. Another prediction that her analysis makes is that the vocalic alternations take place in a symmetrical fashion along the same height. This idea is represented graphically below in (16a). On the other hand, (16b) shows the directions of changes which transpire from the data in (15) above. Admittedly, they concern Munster Irish to a greater extent, but they occur in both dialects. This suggests that, some small differences notwithstanding, the two dialects should be offered a uniform analysis, in which we would be able to incorporate height as well as backness.

33 It must be added that both dialects exhibit opaque vowels which are not affected by the property of the following consonant. For example, scoil [skol´] ‘school’, cois [koʃ] ‘leg’, rather than the expected *[keʃ / kiʃ] or *[skel´ / skil´] (e.g. Ó Cuív 1975, de Bhaldraithe 1945). Similar behaviour concerns the back low vowels [ɨ]. For example, bainne ‘milk’ is pronounced as [b¨æːnə] in Munster and [baːNʰə] in Connemara ([N] stands for a tense coronal nasal). The lengthening in Connemara is phonetic.
The illustrations above clearly suggest that the analysis based on spreading \([±BACK]\) idealises the facts slightly in the case of Connemara Irish – as shifts of the type \([a~i], [a~e]\) and \([o~i]\) do occur in this dialect in the relevant phonological contexts –, and it is unable to subsume the Munster facts which involve not only backness but also height distinctions. The latter would have to be dealt with by means of additional patch-up rules. What seems to be required is an analysis which would be able to cover all the facts and the dialectal variation in a simple and elegant fashion. It should also be able to explain how and why vowels of any height tend to alternate with \([i]\) in Munster, and occasionally in Connemara. In other words, there seems to be an asymmetry in the effects of backness spreading which are difficult to express in an equipollent feature system in which \([+BACK]\) should be no different from \([–BACK]\). One would also like to have some explanation of the interesting correlation between the height of the target vowels and the complexity of the facts. Note that the \([u~i]\) alternation is almost exceptionless in both dialects. The \([o~e]\) alternations are almost regular in Connemara, and almost non-existent in Munster, in which \([o~i]\) is the norm. The latter type is only marginal in Connemara, though, much better established than \([o~e]\) in Munster. Thus, the lower we get in terms of the height of the targets, the more complicated the picture gets, and the targets are less and less susceptible to spreading. This also brings up the question of the representation of the short opaque vowels.

Let us briefly compare the story of backness spreading with an element-based analysis. In Cyran (1997), palatalised consonants are defined by the presence of the element \((I)\) which spreads to the preceding nucleus as the head \((I)\). The

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34 There is no denying that one may always resort to feature co-occurrence restrictions to derive these effects. The point is, however, that there is nothing inherent in the two values of the feature \([BACK]\) that would directly express such asymmetries.

35 It is conceivable that they may be lexically specified with the feature \([±BACK]\), similarly to long vowels, which do not participate in the alternations.
velarised series of consonants contains the (U) element, which spreads as an operator. The asymmetry in the status of the spread element is responsible for the fact that (I)-ness dominates the vocalic system of Munster Irish, as we saw above. The so called opaque nuclei are headed, e.g. (A), while the targets of spreading are headless. The short vowel system of Irish may be viewed as a vertical system, very much in the spirit of Ní Chiosáin (1994), but with some crucial differences.

(17) **Short vowels in Irish**

Two comments are in order here. Firstly, we should immediately say that the headed (A) is realised as back after velarised consonants (C^U), and as front after palatalised ones (C^l). In the latter context palatalisation spreading from the right hand context may affect such nuclei leading to [a~i] and [a~e] alternations under the specific contextual conditions discussed in Cyran (1997: 56). Secondly, the reason why (I) and (U) are banished from the lexical representations of alterable short vowels is because these properties are always available from the consonants. However, the headless targets should not be viewed as underspecified vowels which will receive phonetic interpretation only once filled with (I) and (U). In a system in which there would be no element spreading to such nuclei, they would still be interpretable in some way. Finally, a word of comment is in order concerning the concept of spreading, which is fundamentally a derivational notion. In non-derivational parlance, we may say that the domain of phonetic interpretation of the secondary articulation of consonants in Irish is wider than one skeletal position. In this respect, the phonetic interpretation of alterable short vowels in Irish may be said to involve two overlapping domains, that is, the melody lodged in the nucleus and the superimposed melody of the secondary articulation of the following consonant. In what follows the term spreading should be understood in the non-derivational

---

36 Languages with vertical vowel systems of this type do exist. For example, Kabardian has only two short vowels [i, e], but it has a full set of five long ones [i:, u:, e:, o:, a:] (Maddieson 1984: 417).
The alternation \([u\sim i]\) is derived by means of the superimposition of (I) or (U) from the following consonant on a nucleus which otherwise has no melodic content. Since consonants in Irish are always either palatalised or velarised, this structure will always be interpreted as either [i] or [u]. Note that the height of these vowels needs no further specification because this property is inherent in the two elements. In addition to that, because in this instance (I) and (U) meet no other element in the nucleus, this type of alternation is the most regular, as it does not involve any interaction between the lexically present elements and the spread ones.

The situation is different in the case of lexical (A.), responsible for the \([o\sim e]\) and \([o\sim i]\) alternations. Here the dialectal differences between Connemara and Munster are most clear, but only when we talk about palatalisation contexts. Note that the spreading of (U) into the nucleus represented as (A.), that is [o] in both dialects. The problem lies in the way (A) and (I) combine in the two dialects. It appears that in Connemara the incoming (I) may assume the head position to produce (A.I), hence the regular alternation \([o\sim e]\). In Munster Irish, [e] is an extremely restricted vowel. On the basis of other phenomena involving the interaction between (A) and (I), Cyran (1997: 101) proposes that the well-formed (A-I) compound in this dialect is (A)-headed, that is, (A.I). Thus, in the case of vowel-consonant interaction, the incoming (I) element cannot form a grammatically licit compound with (A) and it suppresses the (A) element, or, to put it differently, the element (A) cannot be licensed in the nucleus headed by (I). The same type of (A)-suppression is observed in the \([a\sim i]\) alternation, for example fear / fir [fˈar ~ fˈir] ‘man / gen.sg.’, while in \([a\sim e]\) the phonetic mid vowel survives, but it must receive additional support from the following nucleus, for example, deas / deise [dˈas] ~ [dˈeʃ] ‘nice / gen.sg.’.

The low vowels behave in the most irregular fashion because they are represented by a headed element (A) which interacts with (I)-ness only under strict conditions, if at all. Thus, it seems that the vertical system presented above is able to capture not only the reflexes of spreading and their different outcomes

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37 The scope of the superimposition of secondary articulation in Irish is a complex issue. There are generally two blockers restricting overlapping domains: a) the so called ‘opaque vowels’, b) the specification of the preceding non-adjacent consonant, which marks the beginning of a new domain (Cyran 1997: 50).

38 It is also possible that in Connemara the element (I) spreads as an operator just as (U) does. This could explain why the effects of spreading into a nucleus specified as (A) are symmetrical, that is, (A.U) and (A.I).
by referring to dialect-specific constraints on element combinability, but also straightforwardly captures the correlation between the height of the targets and the relative regularity of the observed alternations. This analysis fully incorporates the properties of backness and height which eluded a uniform analysis in a feature-based model. All the necessary asymmetries can be derived from the general nature of representations in privative models.

In general, the element-based analysis is rather simple and can be summarised as follows. We determine which properties of short nuclei are lexically present, as well as those which are spread from the consonants. The phonetic interpretation of the nuclei will depend on their lexical representation and the spreading of (I) and (U).\(^{39}\) The special status of the [u–i] alternations in both dialects follows from the representation of the target: being melodically empty, it imposes no conditions on the spread property. On the other hand, once a nucleus is specified by the presence of (A) the outcome depends on the combinability of elements. This additional complication is resolved by dialect-specific constraints which allow only grammatically licit structures to be interpreted phonetically. All the alternations boil down to the interaction between elements, or more precisely, to the interaction between the process of element composition in overlapping domains, e.g. \((A_.) + (U) > (A.U_.)\), and well-formedness constraints which either sanction the result of the composition, or not. The latter situation leads to element suppression, e.g. \((A_.) + (I) > (I)\), where the winning property is the stronger, that is, headed one.\(^{40}\)

Further details of this analysis of the alternations in Munster Irish can be found in Cyran (1997), where additional arguments supporting the nature of element interaction in this variety of Irish are sought in other areas of the phonological system, for example, in the analogous behaviour of resonance elements in the consonantal system. Instead of pursuing this idea further, we will now turn to the discussion of some aspects of Irish phonotactics. It will be shown that some issues are compatible with what we now know about sub-segmental complexity, others will require an extension of the model, while yet other problems will have to left unanswered until we arrive at an overall picture of phonological organisation in Government Phonology, including principles of syllabification and the interaction between segmental and syllabic complexities on the one hand and higher prosodic organisation on the other.

\(^{39}\) It must be noted that the properties \((U)\) and \((I)\) are in fact also lexically present in the representation except that they are lodged in a different portion of it.

\(^{40}\) Intuitively, we expect that the headed elements will be stronger in that they will refuse to be affected by incoming properties (opaque short vowels), and they will win in cases of conflict (A-suppression).
4.2. Substantive conditions on Irish epenthesis

The idea that complexity may replace sonority or strength scales is attractive for the simple reason that it is now a derivative of the internal representation of consonants rather than a separately proposed look-up scale whose role in the phonological system is unclear. Once the representations are established for a given system they should display consistent behaviour for all possible phonological phenomena where complexity, sonority, or strength are assumed to play a role. Ideally, we should expect a convergence of unrelated aspects of a given phonological system in the internal structure of its segments.

In this section, we look at two such aspects of the phonological system of Irish. The first is phonotactics, or more specifically, the interaction between consonants in clustering. The second aspect concerns the segmental inventory of Irish and some effects connected with it. The third area which calls for an analysis in terms of elements are the initial consonant mutations, which is attested in other Celtic languages as well. This phenomenon will be only mentioned in passing here. It will be dealt with more fully in the following section in relation to Welsh which will be assumed, quite uncontroversially, to share some properties of its consonantal system with Irish. Here, we will concentrate on one phenomenon concerning the syllable structure of Irish, which is common to all dialects, and which appears to be conditioned by the segmental structure of consonants.

Irish displays a consistent phonotactic pattern in which certain coda-onset contacts are disallowed. To be more precise, only a subset of potentially possible clusters of falling sonority is found in this language. The instances of sequences which are not grammatical are normally assumed to be broken up by epenthesis, which has received a lot of attention in the literature. Descriptions of the facts can be found in, for example, Ó Cuív (1975), de Bhaldraithe (1945), Ó Dochartaigh (1987), Ó Sé (2000), Ó Siadhail (1989), Sjoestedt (1931), Sjoestedt-Jonval (1938), Wagner (1959). Formal accounts include, among others, Cyran (1996b), de Búrca (1981), Green (1997), Ní Chiosáin (1991, 1999), Ó Baoill (1980). Let us consider some examples below, in which the epenthetic vowel is given in superscript.

41 To be fair, phonological theory has witnessed quite a few attempts to encode sonority effects in the internal representation of segments (e.g. Steriade 1982, Clements 1990, Dogil and Luschützky 1990, Rice 1992)
For the sake of the argument, the data include only those forms in which the cluster is followed by a vowel, so that we can uncontroversially speak of the impossibility of establishing coda-onset contacts. The same pattern, however, is attested for these clusters also in the word-final context, for example, fearg [fˈar̩g] ‘anger’, gearb [gˈar̩b] ‘scab’, leirg [lˈar̩g] ‘slope’, bolg [bol̩g] ‘bulging’, seirbhís [siəɾb̪h̪is] ‘sevice’, airgead [aɾ̩g̪əd̩] ‘money’.

b. [dˈar̩f̩ə] dearf̩a ‘proved’
   [kon̩f̩ə] confadh ‘anger’
   [fur̩xə] forcha ‘beetle’
   [dor̩xə] dorcha ‘darkness’
   [form̩d̩u:l̩] formadúil ‘envious’
   [fˈer̩m̩oːr̩f̩ə] feirmeoir ‘farmer’
   [ˈan̩m̩] ainm ‘name’

There is some agreement among linguists concerning the synchronic status of this type of epenthesis. The main argument for this view is based on the way secondary articulation affects clusters in Irish and Scots Gaelic (Clements 1986, Cyran 1996b, Ní Chiosáin 1999). Specifically, true clusters always agree in terms of palatalisation or velarisation. For example, in Irish cearc [kˈark] ‘hen’, the cluster is velarised, while in circe [kˈir̩k̩ə] ‘hen, gen.sg.’ it is palatalised. The same condition holds for the assumed epenthetic sequences, for example, fearg [fˈar̩g] ‘anger’ vs. feirge [fˈer̩g̪ə] ‘anger, gen.sg.’, but not those sequences in which the intervening schwa is unambiguously lexical, for example, capall [kəp̩l] ‘horse’ vs. capaill [kəp̩l̩] ‘horse, pl.’, and not

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42 See Clements (1986) and Ní Chiosáin (1999) for arguments that we are indeed dealing with epenthesis of lexically adjacent clusters. Even if these were lexicalised patterns, they would still demand a formal account.

43 In fact, the discussion in Clements (1986) concerns similar instances of epenthesis in Barra Gaelic, e.g. those described in Borgstrøm (1937).
*[kɔpˈəl’]*. On this basis, we may claim that the epenthesis sequences are lexically adjacent. Leaving the status of epenthesis aside, it seems that one of the reasons for the impossibility of establishing coda-onset contacts is strictly connected with the sub-segmental structure of the second consonant.

The structural description of the process of epenthesis varies depending on which data are assumed to be part of the phenomenon. For example, de Búrca (1981) defines it as vowel insertion “between a sonorant and a non-homorganic voiced obstruent when the cluster is preceded by a short vowel”. However, as the examples in (18b) clearly demonstrate, the second consonant need not be voiced, e.g. *dearfa* [dˈarˠə] ‘proved’, and it need not be an obstruent, e.g. *AINM* [anˠə] ‘name’. A more precise definition of the context for epenthesis is given in Ó Siadhail (1989), where it is described as occurring within a coda-onset cluster if the vowel preceding the cluster is short, and the sonorant is followed by a non-homorganic consonant other than a voiceless stop. This formulation is in fact an accurate description of the contacts which are possible in Irish. In other words, the surviving contacts are those involving homorganicity, or when the second consonant has a particular value for sonority (Ní Chiosáin 1999). The question is, however, if there is any way of capturing where and why the phenomenon of epenthesis actually occurs. Let us look at some data illustrating the good contacts in Irish, which involve a sonorant followed by an obstruent. Again, we limit ourselves to the word-medial context, which differs slightly from the final one. However, these clusters also occur finally, for example, *beirt* [b´eɾ´t´] ‘two people’, *olc* [oIk] ‘bad’, *corp* [kɔrp] ‘body’.

(19)

a. 

\[
\begin{align*}
\text{[fˈulpə]} & \quad \text{sciolpə ‘splinter’} \\
\text{[kɪr′pˈəx]} & \quad \text{coirpeach ‘criminal’} \\
\text{[ɪlˈk̂əs]} & \quad \text{oilceas ‘evil’} \\
\text{[kˈɪɾəpkə]} & \quad \text{circe ‘hen, gen.sg.’} \\
\text{[pəɾˈtəx]} & \quad \text{portach ‘bog’} \\
\text{[ˈbɒltə]} & \quad \text{bailte ‘home, pl.’}
\end{align*}
\]

44 There are three crucial aspects of the context: a) the preceding short vowel, b) the sonorant, c) the non-homorganic consonant other than a voiceless stop (Cyran 1996b). Ní Chiosáin (1999) adds data in which the prosodic structure also seems to play a role.

45 Irish also has clusters of falling sonority with [s, f, x] followed by an obstruent. Here too, certain restrictions hold. For example, [x] can be followed by [t], but not [p] or [k].
b. \[t\text{ˈiːmˈpɔːl}\] timpeall ‘round’
\[miːnˈt̚ɪr\] muintir ‘people’
\[riːnˈk̪ɔr]\ rince ‘dance’
\[baʊnd̚ə\] banda ‘band’
\[fraʊn̩ˈk̪ax\] Francach ‘French’
\[m̩iːln̩ˈʃʊə\] milse ‘sweet, pl.’
\[t̩ɹiːr̩s\] tuirse ‘tiredness’

The data above do not include all the possible types of sonorant – obstruent word-internal clusters, but they illustrate the main tendencies. (19a) shows that clusters in which a sonorant is followed by a voiceless stop are not broken up by epenthesis. On the other hand, (19b) illustrates an additional interesting phenomenon which is optional in Connemara but fairly regular in Munster: the homorganic clusters are often preceded by a long nucleus. Some of these are cases of lengthening before the homorganic sonorant – obstruent clusters, for example, milse [mˈiːlˈʃʊə] ‘sweet, pl.’, others are much more complicated. However, the main point is that for cluster integrity to be maintained, the second member should be either homorganic (milse, banda), or a voiceless stop (circe, sciolpa). We will not pursue the question of how homorganicity contributes to cluster integrity, though this is not an uncommon situation in languages in general (e.g. Hayes 1986). We are interested in seeing how sub-segmental representation in terms of elements can enable us to understand the fact that, apart from cases of homorganicity, only the voiceless stops make good contacts for the preceding sonorants.

In models operating with sonority the obvious solution to the above question would be that the voiceless stops are the least sonorous, and therefore, together with the preceding sonorant, they provide the biggest sonority slope. Likewise, in models using consonantal strength in the definition of preferred contacts, the voiceless stops are considered to be the strongest. First, it will be shown that the Element Theory correctly identifies the voiceless stops in Irish as the class with the highest complexity, in which case the interpretation of the preferred contacts would go along the same lines as in sonority and strength models. This will be followed by a proposal which, if right, points to the voiceless stops in Irish as the only class of obstruents which may form a complexity slope with a preceding

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46 For a formal analysis of the difference between milse [mˈiːlˈʃʊə] ‘sweet, pl.’ and tuirse [tɹiːr̩s] ‘tiredness’ see e.g. Cyran (1996a).

47 In the following chapter complexity is integrated into a model of consonant interaction, based on governing relations in which the concept of complexity slopes will become more meaningful.
sonorant, thus explaining why the cut-off point is made at this particular point on
the scale of complexity. Coupled with the homorganicity requirement this
proposal seems to capture the Irish facts directly, by referring to their internal
structure. What is more, the proposal will gain additional support from the
nature of the segmental inventory of Irish, in that it will have some grave
consequences concerning what types of obstruents are utilised in the Irish
system, and how they individually participate in phonological events.

The Element Theory provides a direct means of accounting for sonority
asymmetries of the type observed in Irish. Earlier, in the introduction to
elements we saw that stops are generally the most complex consonants. For
example, ignoring the representation of the laryngeal contrast for the moment,
the scale of relative complexity between [p], [f] and [w] can be represented as
(U,h,?)–(U,h)–(U). In the sketchy discussion of English and Polish branching
onsets [fr/vr], we also hinted at an asymmetry which follows from the laryngeal
specification. Namely, if a system has fully voiced stops as opposed to voiceless
unaspirated ones, as in Polish, then the former series contains the element (L),
while the latter is lexically unspecified. On the other hand, a contrast between
voiceless aspirated and voiced, as in English, can be represented as (H) versus
nothing.

Irish has voiceless aspirated stops, and should be represented in the same way
as English. Below, a first approximation of the representation of Irish obstruents
is attempted.

(20)  *Irish obstruents*

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>b</th>
<th>t</th>
<th>d</th>
<th>k</th>
<th>g</th>
<th>f</th>
<th>v</th>
<th>s</th>
<th>f</th>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>U</td>
<td>A</td>
<td>A</td>
<td>_</td>
<td>_</td>
<td>U</td>
<td>U</td>
<td>A</td>
<td>I</td>
<td>_</td>
<td>_</td>
<td></td>
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<tr>
<td>h</td>
<td>h</td>
<td>h</td>
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<td>H</td>
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<td>H</td>
<td>H</td>
<td>H</td>
<td></td>
<td></td>
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</tbody>
</table>

The representations above clearly demonstrate that stops are the most complex
of obstruents as they have the additional element (?). Among the stops, however,
the voiceless ones are still more complex as they possess the high tone element,
whereas no element specifies the voiced series. Thus, it seems that we are able to
point to a precise place on the complexity scale pertaining to the Irish obstruents
where voiceless stops begin to pattern on their own, in contradistinction to the
remaining obstruents. Note that voiced stops have exactly the same complexity
as the voiceless fricatives, that is, three elements. Thus, we may predict that if
the cut-off point was made one element lower on the complexity scale, then voiceless stops would pattern with voiced stops and voiceless fricatives. However, in Irish, the cut-off point sets the voiceless stops aside from the remaining obstruents.

The question arises as to how we should treat the place-defining elements with respect to complexity slopes. If they count, then Irish [k] should pattern with voiced stops, and we should expect it to feature in the data illustrating epenthesis, which is not the case. We assume that the resonance elements do contribute to the inherent complexity of segments, but they do not play much of a role in the complexity profiles for the simple reason that complexity profiles take into account two adjacent segments, each of which contains resonance elements. For example, sonorants like [r] will be defined by resonance elements only, thus, the presence of resonance elements will normally cancel one another out in complexity slopes between sonorants and obstruents. The situation can to some extent be compared to the specification of the secondary articulation in Irish by means of the presence of (I) or (U). Since both consonants of a cluster are affected by these elements, the secondary articulation, just like the primary place does not add anything to the overall slope of complexity. Nevertheless, to return to the question of velarity, this means that the use of a neutral or some other element for velarity may need to be reverted to. With this possibility in mind we assume that generally the resonance elements do not contribute to the complexity slopes. However, they play an important role in the aforementioned homorganicity condition. Let us look at the representation of good (e.g. *coirpeach* [k̂r̷ˈp̷ˈax̷] ‘criminal’), acceptable (e.g. *banda* [ˈbaund̷] ‘band’) and illegal contacts (e.g. *geirbe* [ˈg̷ˈe̷r̷ˈb̷ˈa̷] ‘scab, gen.sg.’) with respect to their complexity slopes. The secondary articulation is ignored.

(21)

<table>
<thead>
<tr>
<th>a. /kɪ r̷ˈ p̷ˈ ax/</th>
<th>b. /bau n d ə/</th>
<th>c. /g̷ˈe̷ r̷ˈ b̷ˈ a̷/</th>
</tr>
</thead>
<tbody>
<tr>
<td>A U</td>
<td>A=A</td>
<td>A U</td>
</tr>
<tr>
<td>h</td>
<td>N h</td>
<td>h</td>
</tr>
<tr>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>H</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The above structures represent a scale of preferences which can be interpreted in the following way. Clusters with a complexity differential of three elements display integrity (21a) and are never broken up by an epenthetic vowel. On the other hand, clusters in which the differential is two elements or less must be
broken up by epenthesis (21c), unless they share the same place elements, in which case the integrity is retained (21b), as in partial geminates.

The representations in (21) show that complexity, coupled with additional conditions such as the one on homorganicity, can account for this particular tendency in Irish phonotactics. It should be stressed that the distinction between voiceless and voiced stops which in this model follows directly from the specification of the laryngeal dimension is not always obvious in models based on strength or sonority.\(^{48}\) Thus, so far, the Element Theory may be said to cover similar empirical ground as sonority and strength-based models. The question is if it can do better. One question which remains unanswered is why such stringent conditions on clustering should hold in Irish.\(^{49}\) Harris (1990), in his first discussion of element complexity and syllable contacts claims that sometimes the accepted coda-onset clusters may have even equal complexity. Why is an obstruent which is more complex from the preceding sonorant by two elements not a good contact? The answer to this question is two-fold. Firstly, substantive complexity merely provides a non-arbitrary scale with cut-off points. However, where exactly the grammar of a particular language chooses to place the divisions is an arbitrary property of that grammatical system. Secondly, we must nonetheless seek to find as much rationale for particular grammatical choices within a given system, rather than contending ourselves with mere definitions of where the cut-off points lie. It seems that we may actually refine our understanding of the Irish restrictions a little further by making a particular systemic claim.

The claim we want to make concerns the systematic absence of the noise element (h) in the Irish language, and possibly also Welsh, as will be shown in the following section. This proposal was first made in Cyran (1996a) and argued for on the basis of a number of phonological phenomena in Irish. Some of the consequences of the assumption will be reviewed in the following sub-section, and further arguments will be provided on the basis of a new analysis of the initial mutations in Welsh. Let us first see how the scale of preferred clusters looks after this innovation, before we offer some additional support for the claim, which is based on the analysis of the segmental inventory of Irish.

\(^{48}\) For example, Clements (1990) proposes a universal sonority scale in which no distinction is made between stops and fricatives, not to mention one between voiced and voiceless stops, a distinction which seems to be called for in Irish.

\(^{49}\) In the following chapter, we will see that in Dutch the conditions on cluster integrity are quite different and, to some extent, are independent of the segmental structure of consonants.
Notice that the systematic absence of the noise element makes all the obstruents weaker, but the voiceless stops continue to be the most complex. The question why [rb] is still not a good contact in Irish must be answered on the basis of other aspects of syllabification. Recall that such clusters should be possible even in Irish if the preceding nucleus is long. Thus, the one element advantage of [b] over [r] may come in handy in those contexts. However, given that the general principle that good contacts are those with steep complexity slope still holds, we can make viable comparisons of Irish with other languages, and at least explain why the same cluster will be better off in a system like English or Polish.

In fact, the best [rb] contact is found in Polish in which voiced obstruents have an additional element (L). Note that even in contexts for devoicing, that is, (L)-delinking, the Polish cluster [rp] will still exhibit the same complexity slope as English [rb] (23b) or Irish [rp] (23a). Thus, Irish [rp] patterns with Polish and English in terms of its complexity differential as well as in showing no epenthesis. Note that the Irish [rb] sequence exhibits some degree of complexity steepness but is still disallowed, in contradistinction to Harris’ position that coda-onset sequences may be even equal in terms of complexity. This question will be taken up in the following chapters. It seems that some additional factor is

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50 Unfortunately we can not include every aspect of the phonological structure of words in Irish in this discussion. A full analysis is offered in Cyran (in prep.).

51 Let us assume that we are dealing with a rhotic variety of English, that is one in which [r] is pronounced in the coda.
at play, which makes such contacts possible in, for example, English, but totally illicit in Irish.

In what follows we will take a closer look at elemental representations of Irish consonants in the light of this new assumption concerning the noise element, and see how the segmental inventory and certain phonological processes can now be understood better.

### 4.3. Segmental inventories and complexity

There are two aspects of the consonant system of Irish which attract one’s attention immediately. The first one concerns the quality distinction between the palatalised and velarised series, which was briefly mentioned earlier in the discussion of vocalic alternations. The second characteristic feature is the presence of word-initial consonant mutations which occur in particular morphosyntactic contexts. In the list of consonants below, palatalisation is marked by the diacritic ‘´’, while velarisation is not represented by any diacritic.

(24) **Irish consonants**

<table>
<thead>
<tr>
<th>Labial</th>
<th>(p, p´, b, b´, f, f´, v, v´, m, m´)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronal</td>
<td>(t, t´, d, d´, s, f, n, n´, l, l´, r, r´)</td>
</tr>
<tr>
<td>Velar</td>
<td>(k, k´, g, g´, k, k´, g, g´, x, x´, y, y´, η, η´)</td>
</tr>
<tr>
<td>Glottal</td>
<td>(h, h´)</td>
</tr>
</tbody>
</table>

A few comments are in order here concerning the status of the consonants listed above. In word-initial position [x, x´, h´, v, v´, y, y´] occur only in lenition contexts, that is, they are derived, as it were, from [k, k´, j, b, m, f, b´, m´, f´, g, d, g´, d´]. Of these restricted fricatives, [x] has the widest distribution as it also occurs intervocally, in clusters, and word-finally. [v] tends to freely alternate with [w] word-initially. Both [v] and [v´] are found finally, but they tend to be elided in intervocalic position, as will be shown later. On the other hand, [f] is restricted in word-final position to two items which may be native and a handful of borrowings (see Doyle and Gussmann 1996: 135). And finally, the pair [γ, γ´] is not found outside the initial mutation context. Thus, in general, what is striking is the restricted distribution of fricatives other than [f, s, j, x], that is, a very low profile is kept by the voiced fricatives, a point which calls for a principled account.

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52 An analysis of initial mutations in a related language, that is, Welsh is offered in the following section.

53 The palatalised version of [s], that is, [ʃ] is in fact palatal.
In order to see the peculiarities of the Irish system better it will be compared with that of Polish, and later with Malakmalak. The palatalised / velarised distinction in Irish is disregarded in what follows.

(25) | plosives | affricates | fricatives |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Polish</strong></td>
<td>p t k</td>
<td>ts tc tf</td>
</tr>
<tr>
<td></td>
<td>b d g</td>
<td>dz dz d3</td>
</tr>
<tr>
<td><strong>Irish</strong></td>
<td>p t k</td>
<td>− − −</td>
</tr>
<tr>
<td></td>
<td>b d g</td>
<td>− − −</td>
</tr>
<tr>
<td><strong>Malakmalak</strong></td>
<td>p t t j k</td>
<td>− − −</td>
</tr>
<tr>
<td></td>
<td>− − − −</td>
<td>− − −</td>
</tr>
</tbody>
</table>

Let us first identify the similarities and differences between Polish and Irish obstruents. In broad phonemic terms, the two languages seem to have analogous systems of stops. Practically, this is where the surface similarities end. Polish has a group of affricates while Irish has none. And finally, while Polish has a fairly symmetrical system among the fricatives in terms of voicing which is also reflected in its affricates and stops, Irish has a defective system in which the voiceless fricatives seem to be independent, while the voiced ones are highly restricted, or virtually non-existent. One might ask a number of questions concerning the defective Irish system, for example, why there are voice contrasts among the stops but not among the fricatives? Could we expect the reverse situation? What is the nature of the gap concerning the affricates? Could we predict a system in which there are no fricatives, but there are voiceless affricates? Is there any formal connection between the absence/presence of voice contrasts among fricatives and the absence/presence of affricates?

It seems that most of the above questions can be answered by referring to a single representational aspect which makes all the difference between Polish and Irish. The answer involves the hypothesis that Irish does not make use of the

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54 Malakmalak is an Australian language whose consonantal system involves the following objects (Maddieson 1984: 327): Stops: p, t, t, k; Nasals: m, n, n, n; Liquids: r, l, l, j, w. The superscripted “i” denotes palato-alveolars, contrasting with alveolars.

55 Marginally, one comes across instances of [d3] and [z] in Irish. However, they can hardly be treated as part of the phonological system.

56 In Donegal Irish palatalised dentals are pronounced with affrication (Dochartaigh 1987). However, this need not be viewed as the presence of affricates in the system.
noise element (h). Metaphorically, we may say that Polish is a ‘noisy’ language, while Irish is ‘noiseless’. Let us compare the representations of obstruents in Polish and Irish beginning with the stops.

(26)

<table>
<thead>
<tr>
<th>Polish stops</th>
<th>Irish stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>[b] [p] [d] [t] [g] [k]</td>
<td>[p] [b] [t] [d] [k] [g]</td>
</tr>
<tr>
<td>U U A A _ _</td>
<td>U U A A _ _</td>
</tr>
<tr>
<td>h h h h h h</td>
<td>? ? ? ? ? ?</td>
</tr>
<tr>
<td>L L L L L L</td>
<td></td>
</tr>
</tbody>
</table>

The above representations show how identically looking segmental inventories of stops are dramatically different phonologically. In other words, they show that making lists of segments or phonemic inventories is both futile and misleading. Firstly, the voice specification is different in that Polish uses (L) versus nothing, whereas Irish has (H) versus nothing. Secondly, the noise element (h) features with a vengeance in Polish, but is completely missing in Irish. It is only to be expected that the two systems will also behave differently. In Polish we have devoicing of obstruents, while in Irish the more complex character of the voiceless stops plays an important role in clustering, as we saw in the previous sub-section. What is worth noting is the representation of [g] in Irish which is as different from its Polish counterpart as can be. As we will see shortly, the simplex representation of this consonant allows us to understand why this is the only stop in Irish which is deleted intervocalically. To conclude our discussion of Irish stops, we must emphasise the fact that, despite the impoverished representations, all the existing contrasts in Irish are captured in our system.

The problem of the absence of affricates in Irish may follow from the absence of (h) as well. Harris (1990) proposes that the representation of affricates involves a contour structure whereby the relation between stopness (?) and noise (h) is broken up. Below we give tentative representations of Polish affricates, with headedness deliberately unspecified.

(27)

<table>
<thead>
<tr>
<th>Polish affricates</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ts] [dz] [tc] [dz] [tf] [dʒ]</td>
</tr>
<tr>
<td>A A A.I A.I I I</td>
</tr>
<tr>
<td>\ \ \ \ \ \</td>
</tr>
<tr>
<td>? h ? h ? h ? h ? h</td>
</tr>
<tr>
<td>L L L L</td>
</tr>
</tbody>
</table>

Chapter 1
Whether affricates are indeed contour structures, or the mere presence of ‘noise’ brings out the effect of affrication, one thing is clear. A system without ‘noise’ should not have affricates, and Irish is such a system.

Below we consider the difference between Polish and Irish fricatives. This class of segments is the most interesting with respect to the proposal that ‘noise’ is missing in Irish, because this category is normally responsible for aperiodic energy in the acoustic signal, that is, friction. However, with the discovery that the headedness of resonance elements, which produces tenseness in vowels, may also bring about the stronger articulation in non-vocalic positions, the representation of fricatives without noise becomes possible (Cyran 1996a, Ritter 1997). Thus, for example, fluctuations of the type [v~w] and [r~r] in Irish can be viewed as (U)~(U) and (A)~(A) respectively.58

(28) | Polish fricatives | Irish fricatives |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[v][f]</td>
<td>[f]</td>
</tr>
<tr>
<td>[z][s]</td>
<td>[s]</td>
</tr>
<tr>
<td>[c]</td>
<td>[c]</td>
</tr>
<tr>
<td>[z][f]</td>
<td>[f]</td>
</tr>
<tr>
<td>[x]</td>
<td>[x]</td>
</tr>
<tr>
<td>U U</td>
<td>U U</td>
</tr>
<tr>
<td>A A</td>
<td>A A</td>
</tr>
<tr>
<td>A I</td>
<td>I I</td>
</tr>
<tr>
<td>I _</td>
<td>I _</td>
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<tr>
<td>h h</td>
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<td>h h</td>
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<td>h h</td>
<td>h h</td>
</tr>
<tr>
<td>h h</td>
<td>h h</td>
</tr>
</tbody>
</table>

Note that this way of representing the Irish fricatives suggests that the voiceless series contrasts directly with glides and liquids and not with voiced fricatives. Specifically, [f] contrasts directly with an object which is sonorant-like in character, as it is represented only by one resonance element (U).59 The variation [w~v] word-initially can be captured as a fluctuation between the headed and the headless element (U), just as the fluctuations between the trilled and flapped [r]-sounds in this language may be viewed as (A)~(A). Note that [s] directly

---

57 See Rubach (1994) for a proposal that Polish affricates are strident stops from the point of view of phonology, and also Rennison (1998) who considers other formal devices to replace contour structure. Rennison’s proposal still relies on a physical presence of particular primes, in this case the ‘noise’ element.

58 See Cyran and Nilsson (1998) for a discussion of the Slavic shift [w] > [v] which involves two different alternations: [w~v], that is (U)~(U), and [v~f], that is (U,h,L)~(U,h). See also Golston and van der Hulst (2000) who derive stricture from structure rather than from a separate melodic prime.

59 The voiced labial fricative is notorious for displaying sonorant-like characteristics cross-linguistically. This is true of, for example, Russian (Andersen 1969), Polish (Gussmann 1981, 2002), Slovak (Rubach 1993), Hungarian (Siptár 1996, Szigetvári 1998).
contrasts with [r], hence there is no [z] in Irish.\(^{60}\) On the other hand, [j] directly contrasts with [j]. In fact, the palatal glide in Irish also has a near-fricative realisation, that is, [j]. It seems that we can also account for the most restricted Irish fricative, that is [γ], which occurs only as a result of lenition word-initially. Depending on the way we represent velarity, this segment is the realisation of a neutral element, or, as suggested by the above representations, it is the phonetic interpretation of an empty onset.\(^{61}\)

In general, the existing phonetic voiced fricatives in Irish are not full-fledged phonological objects, which is a result of the missing noise element and the fact that voiced friction is derived by other, less stable means, that is headedness. Thus, it seems that the systematic absence of (h) almost single-handedly accounts for the distinctions between Polish and Irish obstruent systems. What initially appears to be a defective and asymmetrical system, turns out to be perfectly symmetrical. Its defective nature follows from the fact that not all universally recognised primes are utilised. This analysis demonstrates that it is impossible and hence erroneous to determine the phonological composition of segments on phonetic grounds. Almost every obstruent in Irish differs markedly from the phonetically corresponding object in Polish.

Before, we consider other effects that seem to fall out form the ‘no-noise’ assumption in Irish, let us say a few words about Malakmalak. It seems that the consonant system of this language can be characterised first of all as ‘toneless’, hence there is only one series of stops, that is the voiceless unaspirated one. This is also ‘noiseless’, and hence excludes affricates and fricatives. Potentially, such a system could have voiced fricatives if its resonance elements could be headed. Since there are only glides and liquids, we may assume that this language does not utilise headedness either. These three properties of the consonantal system suffice to express, rather superficially, the differences between this language on the one hand and Polish and Irish on the other. Since no analysis of Malalkmalak

\(^{60}\) Irish seems to be the type of system that, provided it had a process of H-deletion, would exhibit the rhotacism of [s] > [r] instead of the voicing of [s] > [z] in a process like Verner’s Law which generally voices obstruents (Cyran 1997: 192).

\(^{61}\) Empty onsets in Irish may license velarisation or palatalisation (Cyran 1997), hence, [γ] and [γ’] could indeed be treated as empty onsets with secondary articulation, a situation comparable to the [u~i] alternations discussed in 4.1., where nuclei had no specification and were interpreted as [u] or [i] depending on what secondary specification was lodged on the following consonant. Note that [γ’] is in fact [j], that is, a palatal fricative, and as we remember, the (I) element of palatalisation affects objects as the head, hence the friction is expected in each such case. For this reason Irish does not exhibit the alternation [j]~[j], that is a (I)~(I.) fluctuation (Ó Cuív 1975: 42).
is provided here, the above definition of its consonantal system must, of course, be viewed as a sheer speculation.

Returning, again, to the Irish consonants we must emphasise that the impoverished system allows us to understand better quite a number of seemingly unrelated issues. Firstly, we saw that the less complex nature of Irish obstruents sets it clearly apart from ‘noisy’ languages such as English and Polish in terms of phonotactic restrictions, or more specifically, clustering. The uniform absence of ‘noise’ also accounts for some crucial aspects of the segmental inventory of Irish consonants, in particular, the absence of voice oppositions among the fricatives and the complete absence of affricates. It seems that we also gain an insight into a few other phenomena concerning Irish consonants. For example, in lenition contexts, [m] and [b] lenite to [v]. If the fricative were a typical obstruent containing (h), we would be able to understand [b] > [v], but not [m] > [v], in which case the phenomenon would have to involve the loss of nasality and the addition of noise. Under the ‘no-noise’ assumption this problem is nonexistent, as the shift [m] > [v] is simply (U, N) > (U).

Earlier, in our discussion of Irish stops, we mentioned that [g] is now a simplex object (?). On the other hand, in models operating with sonority or strength scales the position of this segment in Irish should be relatively analogous to that of [g] in English or Polish. For these models, deletion of [g] in intervocalic position, or in Welsh mutations (see section 5), is a complete accident. In a model operating with sub-segmental complexity in terms of elements, this is fully predicted, given the correctness of the ‘no-noise’ hypothesis.. Let us consider the following phenomenon. Two segments, [g] and [v], tend to be deleted in intervocalic position in Munster Irish. As a result, a long vowel is created. The velar plosive is lost in the verbal system when the first person ending −im is added to a stem ending in this consonant (29a). That the ending contains a lexical vowel is shown by such forms as las / lasaim [l̞as / l̞asim] ‘light / I light’. The labial fricative, on the other hand, is lost in the nominal system when a vocalic ending is added (29b). In this case, we are dealing with the same kind of genitive formation as in cearc / circe [k̞ark / k̞ir̞k̞e] ‘hen / gen.sg.’, that is, by addition of the ending −e, which palatalises the preceding consonant.

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62 One should bear in mind that the presence of (h) does not guarantee the presence of affricates. What is meant here is that the absence of (h) in a system means that it will not have such objects.

63 The following section deals with Celtic mutations in much more detail.
The question is what [g] and [v] have in common to be deleted intervocically, or what makes them different from other consonants? A quick look at the representation of these objects in terms of elements tells us that the two consonants are mono-elemental. Note that in the lenition trajectories discussed in, for example, Lass (1984), or Harris (1990, 1996) the pre-deletion stages usually involve simplex objects like glottal stops [ʔ], or glottal fricatives [h], which in the Element Theory are simplex objects. What the pre-deletion stages of Irish [g] and [v] have in common with other known types of deletable objects is precisely the same complexity, that is, being represented by only one element. This connection does not follow from any scale of sonority or strength unless the scales are seriously manipulated, or arbitrarily set on the basis of observation. In our model, such facts follow directly from the internal representation of consonants in a given system, which must be first arrived at through analysis. Note that the representation of Irish obstruents has been shown to be connected with a few disconnected aspects of the phonological system. These areas are phonotactics, segmental inventories, and phonological processes. In the following section the complexity-based model is tested against the well-known phenomenon of consonant mutations. This will be done on the basis of data from Welsh, which, like Irish, is a Celtic language.

64 This form is pronounced as [iv ə] in Connemara and Donegal Irish.
5. Initial consonant mutations in Welsh

5.1. Introduction

Alternations of initial consonants, called mutations, are among the most distinctive traits of Celtic languages. As a result of these mutations, a few different surface forms of a given lexical item can be observed depending on the grammatical context. For example, the Welsh word *cath* [kaːθ] ‘cat’ begins with a voiceless velar plosive in the phrase *eu cath* [i kaːθ] ‘their cat’, but there is a corresponding voiced plosive in the phrase *ei gath* [i gaːθ] ‘his cat’, a voiceless velar fricative in *ei chath* [i xaːθ] ‘her cat’, and a voiceless velar nasal as in *fy nghath* [və ɬaːθ] ‘my cat’. Similar effects are observed in Irish as well. For example, the word *cara* [kaɾa] ‘friend’ appears as [ə xaɾə] ‘his friend’, [ə gaɾə] ‘their friend’, and [ə kaɾə] ‘her friend’.

The above examples from Welsh and Irish illustrate two points. Firstly, they show the phonetic correspondences between the various reflexes of the initial consonant, which are clearly phonologically related and do not form an arbitrary set of forms. Secondly, the choice of the examples from the two languages is intentional, as it illustrates the fact that phonetically identical contexts trigger disparate effects on the initial consonant. Thus, the different types of mutations, which are complementary in the respective contexts, are the only exponents of the different meanings.

It is generally assumed among historians of the Celtic languages that originally (4th – 5th century AD.) the mutations were purely phonological phenomena. We may refer to them as sandhi effects, triggered by clearly defined phonological contexts which arose in close syntactic configurations such as preverb + verb, article + noun, or noun + adjective. What is interesting is that the external sandhi phenomena mirrored similar effects within the word, which can be illustrated by such Welsh borrowings from Latin as *apostlus > abostol* [abostol], *peccātum > pechod* [pexod], or *Adam > Addaf* [aːðaf]. The effect of lenition illustrated by the above forms may be given a structural description as occurring in intervocalic position within the word. There is some historical evidence which allows us to assume that the sandhi contexts created similar environments to those in which consonants were lenited word-medially. The

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65 The study of initial consonant mutations in Celtic languages is a well-ploughed area. There are numerous accounts of the phenomenon within a number of theoretical frameworks. The list of authors which follows is only partial and includes works on Welsh, Irish and Scottish Gaelic: Thurneysen (1946), Morgan (1952), Hamp (1951), Ofstedal (1962), Awbery (1973), Pilch (1975), Ewen (1982), Ball and Müller (1992), Ó Siadhail (1989), Ó Cuív (1986), Grijzenhout (1995).
identification of the two contexts can be schematically illustrated in the following fashion.

(30) 
\[ \ldots \text{VCV} \ldots = \ldots \text{V#CV} \ldots \]

The sound shifts within the word were lexicalised, giving *pechod* [pexod] and *Addaf* [aːðav] in modern Welsh, while the sandhi alternations later became grammaticalised (6th century) due to the fact that, for the most part, the phonological triggers disappeared together with the loss of final syllables. Thus, the mutations themselves continued to act as the exponents of gender, number, or case, and *de facto* became part of morpho-syntax rather than phonology proper. However, because of the phonological origin of the mutations and their morphophonological nature in present day Celtic languages, a phonological analysis does not appear inappropriate. It is hoped that it will provide us with indications as to the interaction between phonology and morphology in the Element Theory.

Before we look at possible triggers for the various mutations let us first get a more general view of what can happen to consonants when they are mutated. In order to facilitate the comparison between Irish and Welsh a somewhat simplified picture is presented where the secondary articulation distinctions on Irish consonants are ignored.

(31) **Effects of mutations on a consonant in Irish and Welsh**

**Irish**

<table>
<thead>
<tr>
<th>Basic</th>
<th>k g t d p b s f m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lenition</td>
<td>x y h γ f v h φ v/w</td>
</tr>
<tr>
<td>Eclipsis</td>
<td>g η d n b m - v -</td>
</tr>
</tbody>
</table>

**Welsh**

<table>
<thead>
<tr>
<th>Basic</th>
<th>k g t d p b s f m l ř</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft M.</td>
<td>g φ d ð b v - - v l r</td>
</tr>
<tr>
<td>Aspirate M.</td>
<td>x - θ - f - - - - - -</td>
</tr>
<tr>
<td>Nasal M.</td>
<td>ų ñ ñ n ñ m - - - - -</td>
</tr>
</tbody>
</table>

It has been noted that, if we disregard other minor changes and adjustments in individual cases, the mutations of initial consonants can be captured in terms of
manipulating only three features (e.g. Awbery 1973, Ball and Müller 1992, Fife 1993). This idea is represented below graphically.

(32)

\[
\begin{array}{c}
\text{Irish} \\
\{ \text{Eclipsis} \quad \rightarrow \quad \text{Soft} \}
\end{array}
\begin{array}{c}
[+\text{voiced}] \\
[+\text{nasal}] \\
[+\text{continuant}] \\
\}
\end{array}
\begin{array}{c}
\text{Welsh} \\
\{ \quad \text{Aspirate} \quad \rightarrow \quad \text{Nasal} \}
\end{array}
\]

In real terms, the consonants affected by initial mutations can either become voiced, spirantised, nasalised, or be deleted. Individual modern Celtic languages, however, differ with respect to the actual implementation of the shifts. Thus, in Irish, the process of Eclipsis, which historical descriptions refer to as nasalisation (e.g. Thurneysen 1946), results in the voicing of some obstruents and the turning of others into nasal consonants. Lenition in this language turns stops into fricatives, weakens [s] to [h], deletes [f], and also turns [m] into [v/w], as the list in (31) demonstrates. In Welsh, on the other hand, lenition, which we will call Soft Mutation for reasons to be explained later, either voices or spirantises stops, but it also deletes [g], turns [m] into [v], and voices [l, r] to [l, r]. With respect to the spirantisation of stops, Soft Mutation coincides in its effects with Aspirate Mutation in that both processes involve turning stops into spirants. However, Aspirate Mutation only affects the voiceless stops, which in Soft Mutation are voiced rather than spirantised. Finally, unlike Eclipsis in Irish, the Nasal Mutation in Welsh turns all its targets into nasal sounds, whether voiced or voiceless.

Before we take real data illustrating the mutations in Welsh, let us briefly look at the putative phonological triggers of the mutations, which we can reconstruct to some extent. In general the three main contexts for the consonant changes may be represented in the following fashion.

(33)

\[
\begin{align*}
...V\#CV... & \rightarrow \text{lenition} \\
...s\#CV... & \rightarrow \text{spirantisation or nothing} \\
...n\#CV... & \rightarrow \text{nasalisation}
\end{align*}
\]

Lenition required that the initial consonant found itself in an intervocalic environment. If the first element of a close syntactic unit ended with an [s], this
resulted either in spirantisation of the following initial, or in no change at all. On the other hand, a nasal consonant in that position brought about nasalisation of the following initial. Some examples concerning Welsh and Irish follow below. The capital letter following the forms denotes the type of mutation they caused on the initial consonant of the following attributive adjective. S = Spirantisation / Aspirate mutation, L = Lenition / Soft Mutation, N = Nasalisation / Nasal Mutation / Eclipsis.

(34) **A reconstructed Brittonic o-stem declension** (Russell 1995: 123)

**Singular**

<table>
<thead>
<tr>
<th>Case</th>
<th>Form</th>
<th>Mutation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nom.</td>
<td>*mapos</td>
<td><strong>mab</strong> (+S in Breton)</td>
</tr>
<tr>
<td>Acc.</td>
<td>*mapon</td>
<td><strong>mab</strong>N</td>
</tr>
<tr>
<td>Gen.</td>
<td>*mapir</td>
<td><strong>meib</strong>L</td>
</tr>
<tr>
<td>Dat.</td>
<td>*mapu</td>
<td><strong>meib</strong>L</td>
</tr>
</tbody>
</table>

**Plural**

<table>
<thead>
<tr>
<th>Case</th>
<th>Form</th>
<th>Mutation Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nom.</td>
<td>*mapir</td>
<td><strong>meib</strong>L</td>
</tr>
<tr>
<td>Acc.</td>
<td>*mapus</td>
<td><strong>meib</strong>S</td>
</tr>
<tr>
<td>Gen.</td>
<td>*mapon</td>
<td><strong>mab</strong>N</td>
</tr>
<tr>
<td>Dat.</td>
<td>*mapobi/os</td>
<td><strong>mabof</strong>LS</td>
</tr>
</tbody>
</table>

Although in modern Welsh most of the cases are lost, the former, reconstructed forms for *mab* [ma:b] ‘son’ allow us to identify the connection between the shape of its final syllable and the type of mutation the noun used to impose on the following syntactically close material. A vocalic context led to lenition, a nasal one to nasalisation, and the presence of [s] either led to spirantisation or to nothing. It must be emphasised, however, that the absence of mutation refers to the basic form, sometimes called the ‘radical’ form, which continued to play a role in the alternations and later in the exposition of the particular meanings, just as much as mutated forms did.

The following development in the history of Irish illustrates similar effects, with the additional comparison between masculine and feminine declensions showing the origin of the intricate complementarity of mutation effects which pervades the grammatical systems of Celtic languages even today.
What is interesting in the data above is that the historical mutation effects are retained in modern Irish regardless of the fact that the contexts were opaque as early as the Old Irish period. Note that the nominative form of the masculine noun *duine* ‘man’ did not mutate the following attributive adjective even though the context was vocalic. Likewise, the feminine noun *tóth* ‘tribe, people’, did cause lenition although it ended with a consonant. However, if we go back far enough in the reconstruction of these forms (to Proto-Celtic), we may identify the right contexts and gain some inkling as to when the mutations were full blooded phonological phenomena, and when they became mere exponents of grammatical information such as gender, case, etc.

After this brief and rather general introduction let us examine the effects in more detail. It has been demonstrated that for the most part the phonological triggers have been lost and that the mutations should be looked upon as morphophonological phenomena. However, a phonological characterisation of these effects is very much in order for a variety of reasons. One of them pertains to the fact that the radical and the mutated forms are clearly phonologically related, and the effects are not too different from what they were originally when we could still speak of phonological triggers. In this respect, an understanding of this phenomenon in terms of phonological theory is still warranted and represents a valid test for phonological models. One might consider other reasons for a phonological description of modern Celtic mutations. For example, one would hope that an insightful analysis of the phenomenon would shed some light on the problem of the learnability of such complex phenomena.

However, the main reason why the problem of Welsh mutations is discussed in this work is that it provides us with an opportunity to demonstrate two points concerning the Element Theory. Firstly, we will show how the model is able to simplify analyses of quite complex phenomena. And secondly, given that we are dealing with morphophonological phenomena, the potential merit of such an analysis also lies in the possibility of simplifying the nature of the interaction
between morphology and phonology. We will have more to say on the nature of this interaction in the conclusions to this chapter, as well as in the following chapters, where we discuss phenomena at the syllabic level.

5.2. Soft Mutation (SM)

Soft Mutation, or lenition, is the most pervasive of the initial consonant alternations in that it involves the greatest number of targets and triggers. It is also the most complex mutation in terms of the number of processes involved (Awbery 1973, 1986, Thomas 1992, Ball and Müller 1992, Buczek 1995). To some extent, SM may also be claimed to be a fairly productive phenomenon. Watkins (1993: 306) gives an example of the English borrowing *chips* which begins with a consonant which is not even part of the phonological inventory of Welsh but still gets regularly lenited in colloquial speech producing [dʒips] as in *a bag of chips* [bag o dʒips]. All of the targets, with a sample group of triggers, are represented below.\(^{66}\)

\[(36)\]

<table>
<thead>
<tr>
<th>Target</th>
<th>Example and Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>p &gt; b</td>
<td><em>pen</em> [pen] ‘top, head’ &gt; <em>ar ben</em> [ar ben] ‘on top’ (nouns after prepositions)</td>
</tr>
<tr>
<td>t &gt; d</td>
<td><em>tad</em> [ta:d] ‘father’ &gt; <em>Duw Dad</em> [diu da:d] ‘God the Father’ (a noun in apposition)</td>
</tr>
<tr>
<td>k &gt; g</td>
<td><em>dwâr</em> [du:r] ‘water’, <em>ci</em> [ki:] ‘dog’ &gt; <em>dwrgi</em> [durgi] ‘otter’ (compound)</td>
</tr>
<tr>
<td>b &gt; v</td>
<td><em>bach</em> [ba:x] ‘little’, <em>merch</em> [merx] ‘girl’ &gt; <em>merch fach</em> [merx va:x] ‘little girl’ (adjective following a feminine noun)</td>
</tr>
<tr>
<td>d &gt; ḷ</td>
<td><em>daeth</em> [da:θ] ‘he came’ &gt; <em>yr un a daeth</em> [i:n a da:θ] ‘the one who came’ (after the relative particle <em>a</em>)</td>
</tr>
<tr>
<td>g &gt; ø</td>
<td><em>gárdd</em> [garð] ‘garden’ &gt; <em>yr ardd</em> [i:n arθ] ‘the garden’ (feminine singular noun after definite article)</td>
</tr>
<tr>
<td>l &gt; l</td>
<td><em>llanw</em> [lanu] ‘filling, VN.’ &gt; <em>wrth lanw</em> [urθ lanu] ‘by filling’ (verbal noun after preposition)</td>
</tr>
<tr>
<td>r &gt; r</td>
<td><em>rhaff</em> [ra:f] ‘rope’ &gt; <em>ei raff</em> [i ra:f] ‘his rope’ (noun after masculine singular possessive pronoun)</td>
</tr>
<tr>
<td>m &gt; v</td>
<td><em>merch</em> [merx] ‘girl’ &gt; <em>un ferch</em> [i:n verx] ‘one girl’ (a feminine noun following <em>un ‘one’</em>)</td>
</tr>
</tbody>
</table>

\(^{66}\) For more exhaustive surveys of the triggers of all types of mutations in Welsh see, for example, Williams (1980), Ball and Müller (1992).
Although, as mentioned earlier, all the initial mutations in Celtic languages can be captured by using the three major features mentioned earlier, that is [+voice], [+continuant] and [+nasal], a quick glance at only one type of mutation in Welsh shows that the situation is rather more complex. In pre-theoretical terms we may describe Soft Mutation as involving five processes. The voiceless stops [p, t, k] become voiced [b, d, g], the voiced anterior stops [b, d] become the corresponding voiced fricatives [v, ð], the voiced velar plosive [g] is deleted, the voiceless liquids [l] and [r] are voiced, that is, they become modal liquids, and the bilabial nasal [m] becomes the labio-dental [v].

Ball and Müller (1992), among others, working within a feature-based derivational model, show that these five processes can be collapsed into three if certain assumptions are made. Thus, we may talk about one major voicing process which turns [p, t, k, l, r] into their voiced congeners [b, d, g, l, r]. The second process would involve the spirantising of voiced stops including [g]. For this description to be upheld, we must assume that at some stage of the derivation a voiced velar fricative *[y] is produced which is later deleted by other rules. And finally, the process turning [m] into [v] may be included in the second group, that is spirantisation, under the proviso that, here too, the derivation is allowed to involve an abstract stage with a non-existent nasalised voiced labio-dental fricative *[v], that is $m > *v > v$. Here, parallel to the derivation of $g > *y > ø$, the simplification is effected at the cost of introducing abstract stages and having to posit further adjustment rules to arrive at the correct result.

As for the voicing process, one has to express some reservations concerning the theoretical validity of this generalisation. The problem concerns not so much the formulation of the rule as the representation of the targets and products of the rules. It is normally assumed, at least in privative feature models, that voicing of sonorants is a default property which need not be specified phonologically, while it must be specified in obstruents (e.g. Lombardi 1995). The treatment of plosives and liquids as a natural class for the purpose of unifying the process of SM, in total disregard of the asymmetry in their universal voice specification, seems to be rather dubious.

The spirantising rule, on the other hand, raises the question of the abstractness of phonological derivations, while leaving us with no way of getting around the problem of the need for a number of phonetic adjustment rules, for example, one turning bilabial place into labio-dental in $m > v$. Though we can posit a late rule of *y-deletion or *v-denasalisation, this does not explain why it is the former that is deleted altogether and not the latter. The $m > v$ change also involves a change of major class features.
The above reservations are not real objections as they only describe the necessary additional mechanisms which allow for a full derivation of Soft Mutation within a particular model. The problem, rather, is that the reduction of SM rules to three major ones and a host of minor ones does not convince us that we have simplified anything or indeed understood more than if we reverted to an analysis with five processes. The criterion for a successful analysis of the mutations should probably be one of a better understanding of the phenomenon rather than one of a more general description. As Ball and Müller (1992: 92) themselves rightly note, the complexity of SM may be only apparent and may simply stem from the complicated theoretical mechanisms, invoked to explain it.

The aim of this section is to demonstrate that the key to understanding the mutations better lies not in the reduction of the types of rules in the derivation but in the internal structure of the targets. Thus, we will first try to arrive at some approximation of what the targets of SM are made up of, hoping that the internal structure will not only be reflected in SM – we can always make assumptions concerning the representation which will yield the right results – but will also connect with other areas of Welsh phonology, such as consonant inventory, distribution, phonotactics, or indeed other, seemingly unrelated phonological phenomena. Once we have arrived at the correct representations within the element theory of Government Phonology, the formulation of rules or constraints will hopefully be dramatically simplified. First, however, let us look at the remaining types of mutation in Welsh.

5.3. Aspirate Mutation (AM)

The term ‘aspirate’ is used here in line with other major works on Welsh phonology, and there is no linguistic reason why the more apt term ‘spirant’ should not be used in this context, other than to avoid terminological confusion with SM discussed earlier.

The process of spirantisation affects only three radicals, that is, [p, t, k]. It has more triggering environments than Nasal Mutation, discussed below, but fewer than Soft Mutation. All the triggers are of a lexical type, for example, \textit{ei} ‘her’, \textit{gyda} ‘along with’, \textit{chwe} ‘six’, or \textit{tua} ‘towards’. Some examples are given below.

\begin{verbatim}
(37) Aspirate Mutation

\begin{tabular}{ccc}
\hline
p & > & f \\
\hline
\textit{pen} [pen] & heads & \textit{ei phen} [i fen] & \textit{her head}
\end{tabular}

\begin{tabular}{ccc}
\hline
t & > & \theta \\
\hline
\textit{ty} [ti:] & house & \textit{ei th\textbar y} [i \theta i:] & \textit{her house}
\end{tabular}

\begin{tabular}{ccc}
\hline
k & > & x \\
\hline
\textit{ci} [ki:] & dog & \textit{ei chi} [i xi:] & \textit{her dog}
\end{tabular}
\end{verbatim}
This process can be given a straightforward description in terms of [+continuant], as all the voiceless plosives more or less become the corresponding voiceless spirants. The question, however, which one would like to answer is why only this set of consonants is targeted by AM. Does this fact follow from something, or is it totally accidental? In our analysis we will try to show that there may be a phonological reason why voiceless plosives participate in mutations on a larger scale than any other types of consonants. Let us now look at the last major mutation type in Welsh.

5.4. Nasal Mutation (NM)

This process affects all six stops by nasalising them regardless of whether they are voiced or voiceless. This results in a series of three corresponding nasal consonants for the voiced stops [b, d, g], which become [m, n, ŋ], and in a series of voiceless nasals corresponding in place to the voiceless targets [p, t, k], which become [m, n, ŋ]. NM has the smallest number of triggering environments, and it is the only initial mutation type which seems to have retained its original phonological context in the triggers. That is, with some exceptions, almost all triggers of NM contain a nasal themselves. Below we use examples adapted from Buczek (1995: 203).

(38) Nasal Mutation

\[
\begin{array}{llll}
\text{b} & \to & \text{m} & \text{Bangor} & \to \text{yn Mangor [ɔm 嫚gɔr] ‘in Bangor’} \\
\text{d} & \to & \text{n} & \text{Dyfed} & \to \text{yn Nyfed [ɔn ɲɛd] ‘in Dyfed’} \\
\text{g} & \to & \text{ŋ} & \text{Goginan} & \to \text{yn Ngoginan [ɔŋ ɲɔginan] ‘in Goginan’} \\
\text{p} & \to & \text{m} & \text{Powys} & \to \text{yn Mhowys [ɔm ɲowis] ‘in Powys’} \\
\text{t} & \to & \text{ŋ} & \text{Tresaith} & \to \text{yn Nhresaith [ɔn ɲeɾesaiθ] ‘in Tresaith’} \\
\text{k} & \to & \hat{\text{j}} & \text{Caerdydd} & \to \text{yn Nghaerdydd [ɔŋ ɲɛrdið] ‘in Caerdydd’} \\
\end{array}
\]

67 Labiality is not the main problem in the adjustment of place, as the lenition of [p] yields a labio-dental spirant parallel to the earlier discussed shift [b]>[v] or [m]>[v]. The problem arises with [x] which tends to be pronounced as uvular [χ]. We will ignore this fact in this discussion as it does not bear crucially on the analysis.

68 The nature of the voiceless nasals is debatable. Some realisations are clearly voiceless nasals, while others sound like aspirated voiceless nasals.

69 An interesting case in point is the possessive pronoun *fy* ‘my’ which causes nasalisation in the following noun, for example, *fy mhen* ‘my head’. The standard pronunciation of this pronoun is [va], however, in colloquial speech it is pronounced as [vŋ] and behaves like the preposition *yn* ‘in’ (38) in that the nasal of the possessive pronoun assimilates to the place of the affected consonant. Thus, *fy mhen* ‘my head’ is pronounced as [ɔm ŋɛn].
As shown above, the nasalisation is in some sense reciprocal as the nasal of the preposition assimilates to the place of articulation of the following consonant. One should also note that NM once again raises the question of changes in major class features. Although intuitively this is a simple process of [–nasal] > [+nasal] in the relevant context, the change of [obstruent] to [sonorant] is not as negligible an adjustment as that of bilabial to labio-dental place in for example b > v in SM. The point is that this would not normally be regarded as a minor adjustment, or at least, the criteria for minor and major adjustments are not entirely clear.

5.5. **Hard Mutation (HM)**

Finally, we must mention one more type of consonantal change which resembles the mutations discussed so far, except that it occurs less regularly and in a different context. Hard Mutation, sometimes referred to as ‘provection’, represents effects which seem to be the reverse of Soft Mutation (Ball and Müller 1992: 286) in that the voiced stops [b, d, g] and, less regularly, the voiced fricatives [v, ð] are turned into their voiceless congeners [p, t, k, f, θ]. The changes occur in morpheme-final context and are triggered mainly by the phonological environment, that is, by the following element of a compound or certain derivational endings, for example, verb formation suffixes, which may be characterised as beginning with either [h] or a voiceless obstruent.

\[
\begin{align*}
\text{(39) Hard Mutation} \\
\text{b} & \quad \text{p} \quad \text{bwyd+ha} \to \text{bwyta} \quad \text{[buta]} \quad \text{‘to eat’} \\
\text{d} & \quad \text{t} \quad \text{abad+ty} \to \text{abaty} \quad \text{[abati:]} \quad \text{‘abbey’} \\
\text{g} & \quad \text{k} \quad \text{gwag+ha+u} \to \text{gwacau} \quad \text{[gwa'kai]} \quad \text{‘to empty’}
\end{align*}
\]

In the following sections we will try to understand the various consonantal mutations by first proposing a representation for the relevant consonants. This will lead to a more precise formulation of the changes in phonological terms. It must be remembered that this phonological characterisation merely aims at understanding the phenomenon of initial mutations in terms of the necessary modifications that the segments undergo. Since most of the time the changes are divorced from any traceable phonological triggers, we must content ourselves with simply accounting for the effects.

5.6. **Representing Welsh consonants**

In accounts of the mutations in Welsh we note intuitively that there seems to be a distinction between statements which achieve the status of true generalisations
and mere descriptions. The former kind includes statements which manipulate the features [continuant], [voice] and [nasal], while the latter type supply redundant properties, such as place adjustment in the shift $m > v$, or can even involve a change of major class, as in $b > m$. Thus, there seems to be a set of primes which are pertinent to a particular phenomenon – they tend to coincide with the features surviving in the underlying representations in underspecification frameworks – and properties which consistently turn out to be redundant. The latter form an arbitrary set, and the battery of redundancy rules which is needed to deal with them provides no insight into the phenomenon in question.

After these introductory remarks let us now briefly remind ourselves of the basic tenets of the melodic representation in Government Phonology, and apply the model to the Welsh facts.

The Element Theory in Government Phonology attempts to rid representations of redundancy altogether. It replaces features with primes that enjoy stand-alone interpretability. Each such prime individually or in combination with others is directly mappable onto articulation and auditory perception. Phonological representation in this model is therefore simultaneously redundancy-free and fully interpretable, that is, ready for phonetic implementation with no further specification required (Harris 1996).

The advantage of this model with respect to the problem of redundancy lies in the fact that phonological statements, be they rules or output constraints, refer only to lexically pertinent primes and there is no need to distinguish between true generalisations and other, less important statements. All statements are, in a sense, true generalisations. This model also restricts the nature of rules or constraints. For example, they may refer to combinability of primes or their ability to occur in particular prosodic positions (Harris 1997).

Returning to the representation of Welsh consonants, we will tentatively assume the following representations of place. The labels are not meant to be precise phonetic definitions of place but rather act as rough functional distinctions. Since place of articulation does not play any crucial role in mutations the proposed representations will not be argued for. 70

70 The compound A-I is a shorthand notation which avoids resolving the question as to which of the two elements is the head and which one is the operator. It must be added that the representation of dentality in Welsh does not constitute a universal assumption concerning this place, although the same compound is used to define dentality in Irish and Polish in Cyran (1997: 222).
The manner dimension is more complex and a few comments concerning this aspect of the representation of consonants are needed before we consider the Welsh consonants. Let us again consider the list of manner elements below, based on the work of Harris (1990), Harris and Lindsey (1995).

\[(\text{41})\]

<table>
<thead>
<tr>
<th>Element</th>
<th>Manner</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>labiality</td>
</tr>
<tr>
<td>A-I</td>
<td>dentals</td>
</tr>
<tr>
<td>A</td>
<td>alveolars</td>
</tr>
<tr>
<td>I</td>
<td>palatals</td>
</tr>
<tr>
<td>_</td>
<td>velars</td>
</tr>
</tbody>
</table>

The presence of the occlusion element in plosives is pretty uncontroversial. On the other hand, there are no good reasons to have it in Welsh laterals and nasals. The acoustic definition of (?) is ‘a drop in overall amplitude of the signal’. This may mean complete silence as in stops, or attenuation of energy, as in nasals and laterals. Thus, in theory, there is no reason why occlusion should not be allowed in these consonants. However, there is also no reason why it must be present. Other sonorants, for example, glides, also exhibit attenuation in the signal as compared to vowels, but nobody would claim that this is the result of the presence of occlusion. In this work we will retain this element in laterals for the sake of exposition, whereas in nasals it will be absent.\(^{71}\) It is an inherent property of Element Theory that to obtain a nasal consonant it should be sufficient to have a nasal element and some place specification, underlying or acquired through assimilation. The role of occlusion in this class of consonants requires further research, especially in the light of common assimilations to stops. We will assume that it is absent in nasals unless there are reasons for its presence, in which case we will still get a nasal consonant. In other words, either (U,N) or (U,N,?) will yield \([\text{m}]\), and it is phonology that will tell us which construct we

\(^{71}\) There are facts from other languages which point to the presence of stopness in laterals and nasals. See e.g. the analysis of Icelandic pre-aspiration in Gussmann (1999, 2000).
are dealing with, rather than an *a priori* assumption. This ambiguity, which is inbuilt in Element Theory, has its advantages as we will shortly discover.\(^{72}\)

Returning to nasality for a moment, the general introduction to Celtic mutations at the beginning of this section showed that there seems to be some affinity between nasalisation and voicing. For example, the historical process of nasalisation in Old Irish diverged into two phenomena, that is, nasalisation and voicing. There has been a lot of research into the nature of post-nasal voicing in phonological theory (e.g. Herbert 1986, Itô and Mester 1986, Pater 1996). There are also proposals within the Element Theory which merge the elements (N) and (L) into one, for example, Nasukawa (1998, 2000), and Ploch (1999). In this work we would like to at least bear in mind the possibility that voicing and nasality might be two sides of the same coin. We will represent this option by supplying both elements in relevant contexts, that is (N/L).

The use of the tone elements in the definition of voicing has been described in detail at the beginning of this chapter. Let us only repeat that in systems which have a two-way laryngeal distinction only one of the elements is employed – in the marked series, while the neutral series remains undefined. In Welsh, just as in Irish and English, the marked series is the voiceless or aspirated one, containing the high tone element (H). In the previous section we saw how this asymmetry plays out in the phonotactics of modern Irish. Similar effects can be traced in Welsh. For example, clusters of the type *rg, lg* are absent word-finally and morpheme internally, and the best nasal+stop clusters word finally are those with the voiceless stop and only one voiced, that is, *nd*. Note that while voiced stops generally have one element less than their voiceless congeners, the dental stops are defined by two place elements, which might explain why only *d* is able to appear in clusters with nasals.\(^{73}\)

However, the most significant innovation that we would like to propose with respect to Welsh concerns the noise element (h), or rather its absence from the Welsh consonantal system. We put forward this proposal on the basis of our findings in Irish, discussed in the previous sections. The Welsh system shows all the relevant diagnostic aspects for such a move. First of all, as mentioned above, lenis obstruents in cluster formation are generally weaker. Secondly, systemically acceptable affricates are missing from the system of consonants. And finally, there are no real voice distinctions among the fricatives. The

\(^{72}\) Ambiguous representations yielding identical phonetic effects but at the same time displaying disparate phonological behaviour have been called ‘double agents’ in the Government Phonology literature (Gussmann 2001, 2002).

\(^{73}\) For a recent discussion of similar restrictions on word-final nasal+voiced stop clusters in the dialects of modern English see Gussmann (1998), and Tóth (2002).
voiceless fricatives, specified as possessing (H), contrast directly with sonorants or sonorant-like fricatives. These diagnostic criteria seem to point heavily to the fact that Welsh is an h-less language. The tables below compare two approaches to Welsh consonants and their consequences for the analysis of mutations. One is Buczek (1995) in which the ‘noise’ element (h) is very much part of the system and has a very important function to play, and the other is that advocated in this work, in which (h) is absent altogether from the Welsh system. First we look at Buczek’s proposal.74

(42) Welsh consonants (adapted from Buczek 1995)

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>b</th>
<th>t</th>
<th>d</th>
<th>k</th>
<th>g</th>
<th>l</th>
<th>r</th>
<th>m</th>
<th>n</th>
<th>η</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>U</td>
<td>A-I</td>
<td>A-I</td>
<td>_</td>
<td>_</td>
<td>A</td>
<td>A</td>
<td>U</td>
<td>A-I</td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>h</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

Since there is no crucial difference in the use of place elements and the tone specification of voiceless obstruents between the above table and our proposal below, these will be ignored in the discussion.

The noise element (h) is used in all stops in Buczek (1995), in accordance with the assumption of the early Element Theory that this element is present in released stops (e.g. Harris 1990). By definition, this element is also present in fricatives, but not in all of them. It is missing in the voiced labio-dental fricative, which is represented only by means of (U). This move is dictated by the fact that in Soft Mutation [m] becomes [v]. A description of this process would have to involve not only the loss of nasality, but also the addition of noise to obtain a fricative, a rather complicated procedure. It is also interesting to note that (?) is missing in [m] as opposed to other nasals, clearly to avoid delinking two elements at a time in the shift m > v. However, given the representations of [v] and [b], Buczek cannot avoid delinking two elements in the SM shift b > v

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74 In Buczek (1995), coronality is represented by the element (R) which has since been eliminated from GP. We replace this element with (A) and (A-I).
Substantive complexity

(U,?,h) > (U), unless we assume that there are two types of [v] – one with noise and another without it. However, despite these small inconsistencies, Buczek makes the important point that the noise element can be used to represent voicelessness and aspiration in [l, Ŕ, m, ň, ŕ].

The table below illustrates the option in which the relevant Welsh consonants are devoid of the noise element.

(43) **h-less representation of Welsh consonants**

<table>
<thead>
<tr>
<th>p</th>
<th>b</th>
<th>t</th>
<th>d</th>
<th>k</th>
<th>g</th>
<th>i</th>
<th>r</th>
<th>m</th>
<th>n</th>
<th>ň</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>U</td>
<td>A-I</td>
<td>A-I</td>
<td>_</td>
<td>_</td>
<td>A</td>
<td>A</td>
<td>U</td>
<td>A-I</td>
<td>_</td>
</tr>
<tr>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
<td>H</td>
</tr>
</tbody>
</table>

Note that the stops are still stops because they possess the occlusion element (?), which together with place defining elements and the laryngeal distinction: High tone vs. nothing, fully suffices to define the system. What is interesting is that Welsh stops are generally less complex than in other languages, for example Polish, and that the voiced series is still weaker, with the voiced velar plosive having only one element, the occlusion itself. The same situation was earlier shown to hold also in Irish.

A word of comment is needed concerning Welsh [g]. The phonetic realisation of (?) as [g] cannot be treated as universal. In Welsh, it follows from two conditions; the systemic absence of (h), and the fact that obstruents use (H) in their laryngeal specification. This means that in another h–less system in which (L) is used in obstruents, the sole presence of (?) may produce [k] because [g] in that system would have the Low tone. It appears then, that the phonetic implementation of a given element in Government Phonology, depends not only on its overall acoustic signature but also its place in a particular phonological system. This is one of the reasons why it is erroneous to try and provide element based representations for all the sounds represented in, for example, the IPA chart. The representations should always be system based.

To return to the discussion of the above table, the simplex representation of [v] is now a systemic effect rather than an *ac hoc* solution. Note that we bypass the problem of how many elements will be lost in the shift $m > v$, or $b > v$. In
each case, only one element needs to be lost: either nasality or occlusion respectively.

The absence of (h) in the system requires that a different proposal be made concerning fricatives, sounds in which this element was traditionally indispensable. We assume, following Cyran (1996a, 1997), Ritter (1997), that the headedness of the resonance element may be responsible for the effect of friction. This is true of Welsh [v] = (U), and [ð] = (A-I). Such fricatives are sonorant-like in terms of their behaviour. It is interesting to note that the two fricatives tend to be lost in word-final context in Welsh (Thomas 1992). For example, *gof* ‘blacksmith’ is pronounced as [go:] in the North and [go:v] in the South. Similar effects are found in words like *barf* [bar(v)] ‘beard’ and *gardd* [garð] ‘garden’. The absence of the noise element (h) also enforces a different representation for voiceless liquids and nasals, that is, one in which the high tone (H) is responsible for the voiceless effect. In this way, this group of consonants can be more easily related to the fortis plosives and fricatives.

Let us now look at how the two different approaches to the representation of Welsh consonants affect the analysis of the consonant mutations.

### 5.7. A new analysis of Welsh mutations

The table below is a comparison of two different analyses of the mutations which fall out from the two assumptions concerning the representation of Welsh consonants, which were discussed above. In the Element Theory, only two types of processes are recognised: *composition*, which is basically the addition of elements, and *decomposition*, that is, the deduction of elements. These correspond to fortition and lenition phenomena and are represented in the table as (+) and (–) respectively. The dotted line separates those classes of sounds which require a different analysis in terms of element deduction or addition. Ideally, the groups of consonants which are intuitively perceived as natural classes should receive identical interpretation. Additionally, it is generally recognised within GP that one of the conditions on composition is that the element that is added must have a local source, that is, be present in the representation of the trigger, if this process is to be viewed as phonological.

---

75 Recall that [v] is notorious for acting as a ‘double agent’ not only in Welsh but also in Polish (Gussmann 1981), Irish (Cyran 1997), Russian (Andersen 1969), Hungarian (Szigetvári 1998), Slovak (Rubach 1993) and in the history of a number of Slavic languages (Cyran and Nilsson 1998).
A comparison between a h-full and h-less analyses

(+): addition of elements / fortition, (−): deduction of elements / lenition

<table>
<thead>
<tr>
<th>SOFT M.</th>
<th>Buczek 1995</th>
<th>h-less analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>p &gt; b</td>
<td>–H</td>
<td>–H</td>
</tr>
<tr>
<td>t &gt; d</td>
<td></td>
<td>–? , −h²</td>
</tr>
<tr>
<td>k &gt; g</td>
<td></td>
<td>–?</td>
</tr>
<tr>
<td>b &gt; v</td>
<td>–? , −h</td>
<td>−?</td>
</tr>
<tr>
<td>d &gt; θ</td>
<td></td>
<td>−?</td>
</tr>
<tr>
<td>g &gt; φ</td>
<td>−? , −h</td>
<td>−?</td>
</tr>
<tr>
<td>l &gt; l</td>
<td></td>
<td>−?</td>
</tr>
<tr>
<td>r &gt; r</td>
<td>−h</td>
<td>−H</td>
</tr>
<tr>
<td>m &gt; v</td>
<td>−N</td>
<td>−N/L</td>
</tr>
</tbody>
</table>

ASPIRATE M.

<table>
<thead>
<tr>
<th>NASAL M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>p &gt; f</td>
</tr>
<tr>
<td>t &gt; θ</td>
</tr>
<tr>
<td>k &gt; χ</td>
</tr>
</tbody>
</table>

HARD M.

| b > p   | +H          |
| d > t   | +H          |
| g > k   | +H          |
| v > f   | +H          |
| θ > θ   | +H          |

One immediate observation that can be made is that there are certain aspects which the two analyses share. Some of the mutations in SM, the entire AM and HM receive an identical interpretation, but this is where the similarities end. Let us begin our detailed discussion with Soft Mutation.
The first set of targets, that is \([p,t,k]\) are uniformly turned into voiced stops by means of suppressing the High tone element. Since High tone in Government Phonology may to some extent be equated with the feature \([-\text{voice}]\) in derivational frameworks, this fragment of the analysis is not only identical to Buczek (1995) but also to Awbery (1973) and Ball and Müller (1992).

As for the voiced targets, that is \([b,d,g]\), the \(h\)–less analysis needs only to deduct the occlusion element. Recall that the generative accounts of SM also strove to see the shift \([b,d,g] \rightarrow [v,\delta,\phi]\) as one process. However, the unification resulted in a special treatment of the shift \([g] \rightarrow [\phi]\) which involved a postulation of abstract intermediate stages such as \(g \rightarrow \ast y \rightarrow \phi\). A representation-based analysis bypasses this problem and shows that there is no need for a derivational approach to the seemingly disparate behaviour of \([g]\). Once we arrive at the correct representations within a particular theory, the formulation of the process is quite simple. Since Welsh \([g]\) is represented only by one element \(?\), its deletion results in nothing.\(^{76}\) Note that in Buczek (1995) the situation gets a little complicated here. The shift \([b] \rightarrow [v]\) must involve either deletion of two elements \((U,?,h) \rightarrow (U)\), or alternatively, we must assume that there are two representations of \([v]\) in Welsh, \((U)\) and \((U,h)\). Similarly, in the deletion of \([g]\), two elements must be lost as well. While, theoretically speaking, there is perhaps nothing wrong with losing two elements in some processes, it is not clear how we decide which segments will lose two and which ones only one element in Buczek’s approach. In an \(h\)–less analysis this dilemma is non-existent: it is always only one element which is lost.

The interpretation of the voicing of the voiceless liquids depends on what prime is made responsible for the voicelessness. In this respect, the two analyses appear to be equally appealing in that only one prime is lost. The advantage of one over the other may only be assessed on the basis of the overall system. One argument which we can wheel out in favour of the \(h\)–less analysis is that the voicing of liquids may indeed be grouped with the voicing of fortis plosives, an observation which was also made in generative accounts. Here we are dealing

\(^{76}\) An empty position in Government phonology, be it onset or nucleus, may also have a phonetic interpretation (Kaye, Lowenstamm and Vergnaud 1990, Charette 1991). We may tentatively assume that what is referred to as the historical reflex \(*[\text{y}]\) may have been the interpretation of the empty intervocalic onset which resulted from the loss of occlusion. Likewise, word-initial empty onsets in vowel initial words may be realised as glottal stops. Such effects need not be treated as the realisation of separate elements, but as mere language-specific realisations of empty positions which for one reason or another cannot remain totally empty, for example, due to some language specific constraints on such structures.
with the uniform deletion of the High tone element.\textsuperscript{77} No such unification is possible under Buczek (1995) in which the prime which is lost in liquids is ‘noise’, while the plosives lose the tone element (H).

The final shift in SM, that is \((m > v)\), clearly involves deletion of nasality. It must be recalled however, that in Buczek (1995) this elegant interpretation is achieved at the cost of two assumptions. Firstly, \([m]\) is the only nasal sound with no occlusion element, and secondly, \([v]\) is the only fricative with no noise element. Both facts may however fall out directly from more general assumptions concerning the way elements are harnessed in the definition of sound systems. It should be mentioned that in this analysis the problem of major class features does not arise. The loss of \((N/L)\) from \((N/L,U)\) leaves us with only the labiality element, which has the interpretation of a voiced labio-dental fricative in Welsh. In this respect our account seems to be more adequate than the generative accounts also, which have to adjust major class features as well as the place of articulation in the \(m > v\) shift.

To conclude the discussion of Soft Mutation let us formulate the process in terms of what transpires as a result of the shifts discussed above. First of all, in the Element Theory we may provide a formulation of SM which will only involve the manipulation of one prime at a time. Given the nature of this model, no further adjustments are necessary – the deletion of an element creates a structure which is also independently interpretable, unless what remains is nothing, when we do get phonetic nothing, as in \([g] > [\emptyset]\). Secondly, we lose none of the generalisations made in generative studies which tried to reduce SM to three processes. It seems, in fact, that we can achieve the same generalisations in a more compact fashion because we avoid a lot of the additional adjustments that those frameworks required. What is more, given the possibility of conflation of nasality (N) and Low tone (L) elements, we are able to reduce SM to only two processes, that is, tone deletion, and if the tone is missing in the target – as in the neutral series \([b,d,g]\) – then occlusion is deleted. Note that given the representations of Welsh consonants, there is nothing else left to be deleted except for the place defining elements. But these do not seem to be targets of lenition in Welsh.

It goes without saying that this analysis simplifies the most complex of the initial mutations in a considerable way. The overall principle of SM may be

\textsuperscript{77} Note that we also bypass the problem of specifying liquids as [+voice] as in the generative formulations. The marked case is represented by the voiceless liquids, which have an additional element, and the voicing of the liquids has no particular exponent in the form of a feature or element. They simply become modal liquids which are voiced.
formulated as first targeting tone elements, and if they are missing, then other manner elements. Place elements seem to remain unscathed.

(45)  *A scale of mutation targets in Welsh*

<table>
<thead>
<tr>
<th>Laryngeal</th>
<th>&gt;</th>
<th>Manner</th>
<th>&gt;</th>
<th>Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>H, L/N</td>
<td>&gt;</td>
<td>L/N, ?</td>
<td>&gt;&gt;</td>
<td></td>
</tr>
</tbody>
</table>

The above scheme does not resolve the issue of conflation of nasality with Low tone (L/N), and how this new construct should be categorised. If it is part of the laryngeal node then the mutations may be more readily described as predominantly tonal phenomena, an option to which we will return below.

As mentioned earlier, SM is the most common type of mutation and one with the greatest number of targets and triggers. It seems to be the dominant type of mutation, especially when compared with Aspirate Mutation. In our earlier discussion of the latter we asked the question why AM affects only three targets, while the formulation of AM as delinking of occlusion allows us to cover all stops. We can understand this problem better under two conditions: if the dominant character of Soft Mutation is recognised, and if the formulation of SM given above is correct. Soft Mutation, in a sense, uses up the options that Aspirate Mutation could have utilised.

It is not clear how the dominance should be formalised. It is not impossible that it may be best understood in terms of historical precedence, in which case no theory of the dominance of some types of mutations over others needs to be postulated. On the other hand, some formalisation of the precedence of laryngeal elements as opposed to manner elements as targets of SM seems in place, if only to answer the question why the voiceless stops in SM are voiced, rather than being spirantised on a par with the other plosives.

Whether there is a universal hierarchy determining the propensity of particular elements to undergo deletion, and how this should be expressed in the Element Theory, is an issue for further research. At this stage we just state the fact that in Welsh laryngeal elements tend to be lost more readily than manner elements. Of course, the voiced stops in SM lose occlusion because there is no

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78 Ball and Müller (1992) refer to it as ‘default mutation’.

79 The problem discussed here hinges on what Lass (1984) distinguishes as ‘sonorisation’ versus ‘opening’ in lenition processes. Apparently, the former is less dramatic a change than the latter. However, Lass does not provide a rigorous linguistic argument in support of this impressionistic view.
laryngeal element that could be lost. As for Aspirate Mutation, we must note that the voiceless plosives in Welsh are the only obstruents that have one remaining ‘deletable’ prime that has not been affected by SM. Hence, the occlusion in voiceless plosives is lost in AM. The voiced series of stops cannot be included in this type of mutation because this would lead to grammatical ambiguity – they have already lost their only deletable prime in SM. Thus, voiceless stops in Welsh are the most complex consonants, and this property is directly derived from their internal complexity. Recall that voiceless stops are treated as the strongest and are placed at the beginning of the lenition trajectories discussed in Lass (1984: 178). The Element Theory, in which voiceless stops are the most complex only if specified by (H), also predicts that in systems in which it is the voiced series that is specified – with (L) – the voiceless stops are not the strongest. This allows the Element Theory to avoid the pitfalls of the universal marking of certain segment types as possessing particular characteristics (Foley 1977), and of treating such processes as devoicing in German or Polish as fortition (Lass 1984: 179), rather than the more intuitively correct lenition, or element deduction in prosodically weak positions as the Element Theory has it.

Let us return now to the remaining two mutation types and their analysis within the Element Theory. Nasal Mutation is the only initial consonant mutation which consists in element addition. Recall that most of the triggers contain the nasal property. Here, the h–less analysis is simple again. The stops, whether voiceless or voiced, are affected by nasality. As a result, nasal or nasalised consonants appear as predicted by Element Theory. Given the specification of the targets, where the voiceless series contains (H), the effects of NM seem to be straightforward, though not entirely unusual. Nevertheless, assuming that nasality may combine with (H) in some way, for example as contour structures similar to affricates, we predict that the aspirated / voiceless stops will yield voiceless / aspirated nasals, and voiced stops will simply produce nasals with the same place of articulation. Admittedly, the nasals which result from NM are representationally different from the nasals provided in table (43). The stops contain the occlusion element and therefore we must assume its presence in the nasalised forms. As mentioned earlier, the presence or absence of (ʔ) in nasal consonants changes nothing in terms of phonetic realisation. Both

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80 On this basis it could be claimed that perhaps Nasal Mutation is still a phonological phenomenon.

81 Voiceless or aspirated nasals are certainly a marked phenomenon, just as the voiceless liquids discussed earlier. Some dialects of Welsh, notably the South Glamorgan dialect (Thomas 1984) eschew such structures and of all the voiceless sonorants of Standard Welsh retain only [l].
(N/L,U) and (N/L,U,?) will be realised as [m]. However, while in the case of the basic [m] we have evidence of the absence of occlusion, which is reflected in the effects of SM \((m > v)\), in NM shifts \([b] > [m]\) and \([p] > [m]\) there is positive evidence of its presence, and hence we must accept this presence as a fact.

For Buczek (1995), Nasal Mutation is unduly complex, which is a direct consequence of the assumption that the noise element is responsible for the voicelessness of sonorants. Thus, to get the voiceless nasals, she needs to add nasality and delete the High tone, while for the voiced stops to become nasals, she must add nasality and delete the noise which is present in all stops and which would otherwise produce the voicelessness effect. One general objection that must be raised here is that the process on the one hand clearly consists in element addition, and on the other is assumed to delete elements, the choice of which is quite arbitrary.

Finally, Hard Mutation, which is not an initial consonant mutation but rather a morpheme final one, is also a composition process. It involves addition of the High tone element to the toneless series of stops and, less commonly, the toneless voiced fricatives. Here too, the phonological context is still retained and there are good reasons to assume that it is a phonological phenomenon.

The h–less analysis clearly shows that all the consonant mutations in Welsh can be fairly well understood as predominantly tonal phenomena. The picture is of course more convincing if nasality can indeed be conflated with Low tone into some sort of laryngeal element. Each process targets only one prime, which allows for a neat formulation of the mutations under any framework which decides to use element-based representations, be it a rule- or constraint-based model. This analysis is possible within the Element Theory and under certain assumptions concerning the internal structure of Welsh consonants, for example, the fact that the noise element is totally missing in Welsh. These assumptions find some support within the Welsh system itself, as well as in other Celtic languages such as Irish; the noise parameter was initially proposed for the latter language (Cyran 1996a). In Welsh, we witness a convergence of effects in the mutations with a number of diagnostic criteria for the absence of (h). These include the absence of affricates, and no voice distinctions among the fricatives, whereby the existing voiced fricatives behave as sonorant-like and the voiceless fricatives contrast directly with liquids and glides by means of the (H) element. Just as in Irish, the weakest stop is the voiced velar one, and like in Irish, it is deleted in the relevant contexts. In Welsh, this happens in SM, while in Irish, [g] is deleted in the verbal system when intervocalic, for example, *suigh* ‘sit’ [sig]
loses the stop in suǐm ‘I sit’ [si:m´], when the first person singular ending –im is added.\textsuperscript{82}

Finally, it must be emphasised that this analysis throws new light on the apparent complexity of initial mutations in Welsh from the point of view of learnability and the interaction between morphology and phonology. As for the former issue, given that mutations are predominantly tonal phenomena, the difficulty they present for learners is roughly of the same kind as voice neutralisation is in Polish or German. On the other hand, more needs to be said about the morphophonological nature of mutations. We turn to a brief discussion of this problem below.

5.8. The morphophonology of mutations

At the outset of our discussion of the initial consonant mutations in Welsh, we deemed these effects to be morphophonological. This is no place to deal exhaustively with the concept of morphophonology itself.\textsuperscript{83} Our aim in this section is merely to set out some criteria for deciding whether we are dealing with pure phonological or morphophonological regularities, and to define the nature of the interaction between phonology and morphology that transpires from the analysis of the melodic effects of mutations within the Element Theory, as well as the other facts discussed in this chapter.

The historical perspective on the initial mutations in Celtic languages and the analysis of the modern Welsh phenomena point to the fact that phonological and morphophonological regularities may look very similar. The reason for this state of affairs is simple and follows from the fact that, at least in the case of the mutations, we are dealing with grammaticalisation of phonological regularities. In this respect, the morphophonological effects may be easily confused with phonology proper, because they reflect former rather than current phonological patterns. We will assume that morphophonology is a term which covers cases of petrification of phonological regularities when the phonological system itself develops in such a way that the pattern can no longer be phonological. Thus, morphophonology is a case of systemic conservatism in that it petrifies former states of the phonological system.\textsuperscript{84}

\textsuperscript{82} It is interesting that also the fricative [v] is lost in the two languages, for example, Welsh gof ‘blacksmith’ [go:], and Irish nimh / nimhe ‘poison/gs.’ [n´iv´] / [n´i:].
\textsuperscript{83} For some discussion of the place of morphophonology in linguistic theory see, for example, Dressler (1977, 1985), Gußmann (1985), Kowalik (1997), Laskowski (1975), Trubetzkoy (1931).
\textsuperscript{84} See for example Árnason (1985: 22) for similar views.
At this stage we must mention some criteria on the basis of which something is deemed phonological or is relegated to morphophonology. The Element Theory provides us with some useful tools in this respect, for example, by restricting phonological operations at the melodic level to composition and decomposition. As for composition, the model requires that the added property be locally present. This, to some extent, obtains for the Welsh Nasal and Hard mutations. However, there is a purely grammatical reason why mutations in Celtic languages should not be viewed as automatic phonological effects. The mutations have taken on the grammatical functions of distinguishing gender, case or even tense, and are restricted to particular morpho-syntactic contexts. In other words, not every context where nasality is present will produce Nasal Assimilation. This last point slightly undermines the phonological status of the Nasal Mutation.

As for decomposition, that is, element loss, we may speak of the requirement of a phonologically determinable context triggering the loss. For example, we saw earlier that $g$ and $v$ are deleted intervocalically in modern Irish. However, the contexts in which the initial mutations in both Irish and Welsh originally arose are no longer present due to the historical loss of final syllables. It will be recalled that in present-day Welsh and Irish, the identical phonetic context triggers disparate types of mutations. The facts are repeated below for convenience.

(46)  
Irish cara [kəɾə] ‘friend’
  a chara [ə ɾəɾə] ‘his friend’
  a cara [ə kəɾə] ‘her friend’
  a gara [ə gəɾə] ‘their friend’

Welsh cath [kaːθ] ‘cat’
  ei gath [i gaː θ] ‘his cat’
  ei chath [i xaː θ] ‘her cat’
  eu cath [i kaː θ] ‘their cat’

Thus, to determine whether a regularity is phonological or morphophonological, we may use phonological criteria such as the requirement that added primes be locally present, or the requirement that the suppression of particular primes occurs in specific phonologically definable contexts. We may also find some support for our arguments in grammatical criteria such as the degree of lexicalisation of a particular environment. On the basis of such criteria we may quite definitely claim that, in Welsh, the Soft and Aspirate Mutations belong to
morphophonology, while Hard Mutation can be viewed as phonological according to the criteria we have laid down. In fact, this phenomenon resembles regressive voice assimilation in, for example, the Polish phrase *nasz dom ‘our home’, which is pronounced as [na3 dom] rather than *[naf dom]. As for Nasal Mutation, some criteria, like the local presence of nasality, point to one solution, while others, such as the lexicalisation of the contexts, point to the other.

We will not take a firm position concerning NM and simply accept that morphophonological effects may overlap with phonological ones. The full picture of the mutations in Welsh that transpires from our analysis grades the individual effects on the basis of the criteria we have suggested.

(47)

\[
\begin{array}{ccc}
\text{morphophonology} & \text{???} & \text{phonology} \\
\text{Soft Mutation} & \text{Nasal Mutation} & \text{Hard Mutation} \\
\text{Aspirate Mutation} & \\
\end{array}
\]

It is interesting to note that the uncertain status of Nasal Mutation finds some reflection in the way it is intuitively perceived by Welsh speakers. Recall that there is one particle in standard Welsh, that is, *fy [vɔ] ‘my’, which causes NM while it does not possess nasality itself. In spoken colloquial Welsh, however, this particle is pronounced as [ɔn], thus perhaps reflecting the intuitions of the speakers that Nasal Mutation has its source in the preceding nasal sound. In the following chapter, similar overlapping effects leading to ambiguous interpretations by speakers will be shown to take place also at the syllabic level.

Given that the source of morphophonological regularities lies in phonological patterns, we may make some additional assumptions concerning the nature of morphophonological operations. Specifically, we may tentatively say that in such operations morphology may manipulate any aspect of phonological representation which is manipulable in phonological regularities.85

The nature of the interaction between phonology and morphology in morphophonological phenomena is such that representations resulting from morphophonological operations are fully interpretable by phonology. To make this claim more specific, we may say that in the present day Welsh mutations the suppression or addition of elements making up the word-initial consonants is due to operations which are morphological in character, however, the net result of

\[\text{85 Of course, one must take into account the fact, that, once grammaticalised, the morphophonological operations may become subject to purely morphological processes such as levelling.}\]
these operations is fully interpretable by phonology. From a purely phonological point of view, we need not speak of basic and derived segments. They are all basic in a sense. The source of melodic properties may be lexical or morphophonological but from the phonological point of view they behave identically. In this respect, the representation-based model of phonology, in which the phonological representation is directly mapped onto the acoustic signal, and in which there is no derivation from an underlying structure to a surface one, suggests that morphophonology is indeed only a cover term comprising two phenomena which determine the nature of so called morphophonological effects. Firstly, phonological patterns are turned into morphological ones. Note that the loss of final syllables in Celtic, which carried the phonological information as to what type of mutation was to be caused on the following word, also represented the loss of morphological information – the final syllables which contained inflectional endings. Secondly, morphological derivation leading to so called morphological effects consists merely in manipulating the representation by adding or taking away properties, while the net result of these morphological operations is fully interpretable by phonology. This means that there is no need for a separate module called morphophonology and its only use is as a blanket-term for the effects described above.

The secondary articulation of consonants in modern Irish may be viewed as another example of morphological operations overlapping with phonological effects. Historically, the distinction arose as a phonological pattern whereby consonants had to agree melodically with the following vowels. With the loss of final syllables the regularity was retained and the distinction velarised vs. palatalised on the final consonants was taken over by the grammar, very much like the initial mutations were; this distinction then came to be used as an exponent of grammatical categories such as number or case. For example, in the Irish word *capall* [kəpəl] ‘horse’, the nominative singular is marked by velarisation of the final consonant. In the plural form, however, the sonorant is palatalised, that is *capaill* [kəpəl̪] ‘horse, pl.’. We may say that the alternation [l ~ ɫ] is of a morphophonological nature in the sense that it is morphology that determines the secondary articulation of the final consonant, while the interpretation of the forms is dependent on the phonological system. It will be recalled that velarised and palatalised consonants affect the melody of the preceding short vowel, and that the regularities concerning the nature and scope of this affection are phonologically governed (section 4.1.).

Finally, the criteria for distinguishing between phonological and morphophonological phenomena mentioned above allow us to make particular claims concerning the status of the various palatalisations in Polish. Recall that in the relevant literature we find reference to three major palatalisation effects
concerning velar consonants: a) surface velar palatalisation, b) 1st velar palatalisation and c) 2nd velar palatalisation (Gussmann 1978, 1980, Rubach 1981). Let us observe the structural relationships between the various effects and the representation of velars in the various forms of the word for ‘hand’, that is *ręka*.

(48)  

<table>
<thead>
<tr>
<th>a. surface velar palatalisation</th>
<th>b. 1st velar palatalisation</th>
<th>c. 2nd velar palatalisation</th>
<th>d. representation of velarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>[k´]</td>
<td>[tʃ]</td>
<td>[tʃ]</td>
<td>[k]</td>
</tr>
<tr>
<td>(I._)</td>
<td>(I)</td>
<td>(A-I)</td>
<td>(_)</td>
</tr>
<tr>
<td>?</td>
<td>Ì</td>
<td>Ì</td>
<td>?</td>
</tr>
<tr>
<td>h</td>
<td>? h</td>
<td>? h</td>
<td>h</td>
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</tbody>
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At the outset, let us note that velarity, which has no active place-defining element, is understandably vulnerable to influence from, for example, adjacent vowels. If our representations are correct we can relate [k] with [k´] phonologically in that the context of a front vowel is essential for obtaining the latter object. As for the relationship between [k] and [tʃ], or [k] and [tʃ], we must view them as morphophonologically related for the simple reason that the source of (I) in [tʃ], or (A-I) in [tʃ] is not always present locally, for example, *skok* [skok] ‘a jump’, but *skocz* [skoʃ] ‘jump, imper.’. Likewise, in the case of the so called 2nd velar palatalisation, we might view the −e suffix as the source of (A-I) in [tʃ], but the shift also occurs before −y, for example, *wysoki* ‘tall, masc.sg.’ vs. *wysocy* ‘tall, masc.pl.’.

For this reason, we must assume that the only truly phonological case of palatalisation of velars in modern Polish is the so called surface velar palatalisation. The other two types of alternations are petrified morphophonological phenomena which provide more insight into a potential diachronic analysis of the phonological development of Polish, than into the synchronic state of the phonological system of this language.

In the following chapter, we will point to other instances of morphophonological operations. This time they will concern the syllabic level.
6. Summary and conclusions

In this chapter, we introduced the basic tenets of the Element Theory and attempted to illustrate its application to a number of phonological and morphophonological phenomena. The main characteristics of the melodic primes in this model, that is their autonomous interpretability and privativity, allow us to view the phonological representation as redundancy-free and fully interpretable at any stage of derivation. The latter term is understood as the mere phonetic interpretation of phonological representations which have their source in the lexicon and morphological operations, and does not involve the turning of the abstract underlying representation into a more ‘physical’ surface representation.

It has been shown that a number of phonological phenomena depend on the internal complexity of segments. The relative substantive complexity contributes to an understanding of both the static and dynamic aspects of phonological systems. By static aspects we understand typological and markedness effects as well as such system-specific areas as the segmental inventory and phonotactics. To the dynamic aspect belong historical as well as synchronic phonological processes such as the vocalic alternations of Irish, or voice neutralisation in Polish. It must be emphasised that such processes can be offered a non-derivational account in the Element Theory. While the vocalic alternations of Irish are interpretations of morphologically manipulated phonological representations (composition), the devoicing in Polish consists in the interpretation of segments in which the laryngeal element is not licensed in prosodically weak positions (decomposition).

As regards melodic representations of speech sounds, we tried to demonstrate that the phonological representation should always be determined on the basis of a particular system rather than on the basis of phonetics. The fact that representations in the Element Theory are always system dependent and are not uniform across languages, does not preclude similarities such as those found between the Irish and Welsh consonantal systems, but the model eschews the automatic assignment of representations on the basis of phonetics.

A number of effects can be directly derived from the relative complexity of segments. For example, when coupled with the theory of licensing in phonology, relative complexity corresponds to the relative weight of particular structures. The latter has been held responsible for such markedness effects as vowel reduction to schwa, the raising or lowering of mid vowels, or various laryngeal neutralisations and lenition effects in consonants. All these effects may be uniformly treated as cases of melodic depletion in prosodically weak contexts in our approach.
At the same time, relatively complex objects behave like strong ones in cases where there is a syntagmatic relation with other segments, for example, in phonotactics. In this sense, complexity is able to replace both sonority and strength in phonological theory, while also being able to account for markedness effects.

Complexity defined in terms of the number of privative elements in a segment predicts the existence of asymmetries in phonological systems. The phenomena discussed in this chapter demonstrate that this is a welcome prediction. For example, the relative complexity of the target vowels in Irish vocalic alternations tallies with the relative regularity of the alternations. The asymmetrical representation of laryngeal contrasts, on the other hand, leads to asymmetries in neutralisations, and to particular phonotactic patterns concerning both complex onsets (English vs. Polish \textit{fr/vr}) and coda-onset contacts (Irish ‘epenthesis’).

One of the more important features of the Element Theory is the possibility that not all universally recognised elements may be used in individual systems. Traditionally, this claim has been made about the use of the two laryngeal elements (H/L), in that systems with two-way laryngeal distinctions have been assumed to employ only one of the elements. In this chapter, we considered yet another case of the systemic absence of a prime, which concerned the ‘noise’ element (h). This single parameter accounts for the absence of affricates and voiced fricatives in Irish and Welsh, as well as for the phonological behaviour of consonants in the two languages. If systems can be differentiated by systemic choices of not using particular primes of a universal set, we predict that there may be systems which develop additional primes which the Element Theory has not yet established. It should be the task for further research to determine the status of the currently used primes that can be dispensed with in individual systems, as well as the potential directions in which the model could expand, should the existing set of primes turn out to be insufficient.

Finally, the discussion of the consonant mutations in Welsh aimed at demonstrating how the Element Theory is able to simplify the analysis of this phenomenon if the consonantal system itself is first properly defined. Given additional assumptions, the mutations can be defined as primarily tonal effects. The simplification of the analysis is particularly beneficial in that it offers a simpler view of the interaction between phonology and morphology. We have not attempted to throw any new light on the status of morphophonology in that, like other authors, for example, Árnason (1985) morphophonology is viewed here as a case of systemic conservatism. However, we have shown that morphophonological operations can be much simpler than the approaches using distinctive features and derivation from an underlying representation to a
systematic phonetic level would have it. They only involve the addition or deduction of properties making up the phonological representation.

As for the criteria for determining whether a given phenomenon is phonological or morphophonological, it is clear that they must primarily follow from the phonological theory. The theory must first be able answer the question of what is a possible phonological process. In the Element Theory, there are two main types of processes: composition and decomposition, both of which must occur in a phonologically definable context.

In the following chapter we will first develop a phonological model to deal with syllabification, which will be shown to be based on the interaction between substantive and formal complexity on the one hand, and licensing on the other. We will also attempt to show how the model simplifies the phonology–morphology interactions at this level of representation also.