Consonant Clusters in Strong and Weak Positions

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1. Introduction

Lenition and fortition are melodic effects associated with the prosodic position of a given segment, and the discussion of such phenomena is always two-fold in nature. On the one hand, we have the effects of consonant weakening or strengthening which merit an account relating to the internal structure of segments. This task is not easy when empirical evidence is at stake which takes into account states of a particular sound system from a historical perspective. Nonetheless, this kind of evidence usually prevails in discussions of weakening and strengthening.¹ Synchronically speaking, two aspects of the melodic effects seem to call for attention. Firstly, the dynamic aspect involving synchronic cases of lenition and fortition, and secondly, the static distributional patterns that seem to be correlated with strong and weak positions. On the other hand, the aim of any theory of lenition and fortition is to find a direct and explanatory connection between the effects and the contexts in which they are observed. Also, the theoretical relation between the different types of contexts with respect to each other may become a rewarding subject for study.

As a starting point, this paper takes up the relationship between prosodic contexts and the static distribution of segments, in order to extend the discussion in two directions. One of them is concerned with the place of melodic restrictions on single segments in the broader perspective of phonological representation. It will be shown that consonant clusters share the same fate as single consonants depending on their prosodic position which is definable in exactly the same way and which shows similar typological patterns and markedness tendencies, albeit at a formal level of representation. The other focal point in this paper will be concerned with the definition of strong and weak positions in such a way that the different degrees

¹ This can be observed in a number of papers in this volume.
of strength or weakness of particular prosodic positions is defined in a uniform and non-arbitrary way, while at the same time facilitating a comparison of the distribution of single segments with consonant clusters.

This comparison is possible if we ignore the actual effects other than static distribution. Clearly, it would be difficult to see a similarity between the spirantisation of a consonant and vowel epenthesis breaking up a cluster. Each structure, whether substantive (melodic) or formal (syllabic), has its own battery of phonological effects connected with strong and weak positions, and these cannot be meaningfully compared.

The general key used in this paper to understand the distribution of segments and clusters is the varying degrees of licensing strength that particular prosodic positions exhibit, interacting with the melodic and syllabic complexity (weight) of the structures in question. Initially, licensing will be used rather vaguely as a sanctioning mechanism allowing for particular structures to occur.

The definition will be made more specific in the theoretical part (§ 4), where we find out what the source and targets of licensing are, as well as how strength can be gauged. It will be argued that this varying strength takes the form of a non-arbitrary scale, and that the distribution of segments and clusters is due to their complexity at the melodic and formal levels, thereby posing varying demands on the licenser. If melodic and formal complexities may be subsumed under one term ‘structural complexity’, then the aim of this paper can be defined as an attempt to demonstrate that the distribution of structure depends on the possibility of its licensing. In other words, structure is good but it costs.

Let us begin with the comparison of melodic and clustering restrictions in the context identified by most theories as weak, even if the definitions of the context may differ. The primary aim of this section is to demonstrate that single segments constitute only a fragment of a bigger whole, and that the discussion of strong and weak contexts as well as the corresponding strengthening and weakening effects must not lose sight of the broader perspective.

2. Word-final restrictions

Word-finally, restrictions marshal the melody of single consonants as well as possible cluster types. In this section, some empirical facts are reviewed
concerning the distribution of single consonants and clusters in that position.

2.1. Single segments in the context _#_

The typical melodic restrictions in that position concern, for example, the impossibility of maintaining the voice contrast in obstruents in languages like Polish, Dutch or German. Hence, voiced / voiceless alternations are found in, e.g. Polish *noga / nóg* [noga / nuk] ‘leg, NOMsg. – GENpl.’. This language also exhibits other melodic restrictions in word-final position. Namely, just like the voicing of obstruents, the palatalisation of labial consonants is neutralised word-finally.²

Languages differ in terms of how much melodic material they allow in word-final position. For example, English generally allows any consonant from its inventory to occupy that position except for the glottal fricative [h], and the liquid [r] in non-rhotic varieties. In addition, English has optional weakening phenomena in this context such as the loss of release in stops. On the other hand, Japanese allows for only one type of segment in this context, namely a nasal, e.g. [hon] ‘book’ (Yoshida 1996: 92).

Malayalam (Dravidian) also exhibits only a few contrasts word-finally, though it is slightly less restricted than Japanese. In the formal variety of this language a few segments may be found in that context, namely [m, n, ñ, l, l, r], but all of them must be sonorants (Mohanan 1986: 74).³ Thus, Polish finds itself somewhere between the restricted Japanese and Malayalam cases and the relatively unrestricted English situation.

To complete this gradation of possible consonantal contrasts in the final Coda position, one should mention languages like Zulu and Italian, which do not allow for any consonant word-finally in content words.

It appears, then, that, crosslinguistically, the word-final context presents an interesting scale of the potential number of consonantal contrasts, from

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² For the purpose of this discussion, it is not important how the palatalisation of labials should be best represented. What is crucial is the fact that word-finally it cannot be realised phonetically, just like the voicing of obstruents.

³ [ñ, l] are retroflexed variants, while [ɭ] is a palatalised liquid. Interestingly, in colloquial Malayalam only [m, n] can be found word-finally, e.g. [maɭam] ‘tree’, [awaɭ] ‘he’, while [ñ, l, l, r] must be followed by a schwa, e.g. [aaɭp] ‘male’, [awaɭp] ‘she’, [paɭp] ‘milk’, [wayar] ‘stomach’.
zero in Italian and Zulu to any particular number of possible contrasts within the formal scope of one segment. In other words, once a single consonant position is allowed word-finally, languages may differ as to the types of consonants that may occupy this position.

Thus, next to the formal choice of having or not having a final consonant which expresses the markedness of the right edge of words and is represented in (1) as a vertical scale, there seems to be another scale at the level of one segment, this time expressing potential melodic contrasts licensed by this context. We may refer to the former scale as expressing formal complexity because it refers to syllable structure, while the latter may be termed substantive complexity.

The vertical vector expresses the scale of formal complexity of the final Coda position. Obviously, this scale does not end with one consonant, a point to which we return below.

The substantive complexity scale merely expresses the fact that the weak final Coda context licenses a varying number of contrasts. In other words, its weakness is relative and depends on individual languages. At the same time, it is not entirely arbitrary: some pattern may be discerned regarding the melodic markedness of consonants that appear in this position.

A few comments are in order concerning the placement of Polish and English on the substantive complexity scale, as well as the nature of that scale itself. It appears that the number of possible contrasts in final Codas is almost identical in the two languages. However, English allows for a relatively bigger set of consonants in that position in comparison with its total number of consonantal contrasts: only [h, r] are missing in final Codas. Polish, on the other hand, excludes [m’, v, v’, f’, b, b’, p’, z, z, d, dz, d’z, g] that is, palatalised labials and voiced obstruents. The relative position on the scale for English and Polish is not really important. Both languages illustrate systems in which not only sonorants but also obstruents are allowed in final Codas.
Another point concerning English and Polish that must be mentioned is that these languages are different from Malayalam and Japanese in one more respect. Namely, they may also have word-final clusters. Note that the comparison under (1) takes into account only contrasts relating to one segment. Before we look at these clusters, let us briefly clarify what is substantive complexity and how it may be measured.

The melodic contrasts scale shows a particular pattern. If the number of possible contrasts in the final Coda is limited, then sonorants are very likely to be found in this context. If obstruents are allowed, then, as we saw in Polish, voice contrasts and secondary place of articulation may be lost in final position.

(2) Substantive complexity scale
Sonorants > Plain obstruents > Complex obstruents

This rough scale of melodic complexity merely tells us that it is easiest to license sonorants and most difficult to license complex obstruents. Each of the three categories may need to be spelled out in more detail, which can only be done on the basis of a thorough analysis of a given linguistic system.

The question is how the substantive complexity scale is expressed in the phonological representation of segments. To exemplify this, we may consider the Element Theory of Government Phonology. In the standard version of this model (e.g. Harris 1994, Harris & Lindsey 1995), vowels and consonants are defined by means of eight primes called elements: (A, I, U, N, ?, h, L, H). The complexity of segments may be measured directly by looking at the number of primes that is required to define a given segment. For example, the glides /j, w/, or the glottal stop /ʔ/, are simplex as they contain one element each, that is (I), (U), and (ʔ) respectively. On the other hand, a fully voiced labial plosive in e.g. Polish would be defined by four elements (U, h, ʔ, L).

Bell (1971: 49) lists a number of languages with such restricted final consonants, where nasals, liquids or glottal stops are typical segments used in that position.

Note that this has an immediate positive outcome. Namely, glottal stops are listed by Bell (1971) as the only segments occurring at the end of the word in some languages. The relatively unmarked nature of glottal stops may be derived from their simplex representation.
Thus, according to Element Theory, the substantive complexity may be directly calculated on the basis of the number of elements that define a given segment. Sonorants are ‘light’ and easy to license because they contain one or two elements. Plain obstruents contain two or three elements, while complex obstruents are made of four primes. This rather simplified presentation of elemental complexity is meant to illustrate a possible way of expressing the relation between segmental classes and substantive complexity. It seems intuitively correct to assume that theories which attempt to directly express the relationship between contextual strength and segmental effects by means of representational complexity (rather than building arbitrary scales of segmental propensity to weakening) are superior to those that fail to express this kind of connection.

2.2. Consonant clusters in the context _#

In the previous section we saw the melodic restrictions on single consonants in final Codas. We also introduced the notion of formal complexity which appears to form a scale. Only two points on this scale have been mentioned so far, namely, having no final Coda and having a simplex final Coda. The former situation relates to languages which end their words with vowels only, while the latter refers to languages with one consonant in word-final position. It was mentioned that the formal complexity scale does not end with one final consonant typologically. Polish and English are good examples of languages which allow for complex final Codas, but the phonotactic patterns are quite different.

Generally speaking, English prefers clusters of two consonants which form a falling sonority slope, e.g. bend, belt, camp. This pattern will be represented symbolically as RT, where R may be roughly taken to stand for a sonorant, T for an obstruent. English does not allow for rising sonority clusters word-finally.

Certainly, forms like bottle, with a syllabic sonorant, cannot be treated as a complex Coda with rising sonority. It is true, however, that flat sonority is also observed in English complex Codas, e.g. act, apt, kiln, film etc. It will be shown later that they pattern with falling sonority clusters with respect to their formal structure.

It will soon become obvious that RT stands for a cluster which takes a particular formal representation akin to Coda-Onset in words like winter, brandy, bulky, but also in words like whisper, actor, hefty, etc.
Polish, on the other hand, has both falling and rising sonority in final clusters. But the rising sonority clusters are more restricted melodically than the falling sonority ones. This may be observed in the following fairly exhaustive lists of possible final RTs and TRs in Polish.

(3) a. RT# in Polish

| w, l, rt, n, wp, l,p, rp, mp, wp, ik, r, n,i, t,i,s, t,i,s, w,t,e, r,t,c, w,t,j, t,j, r,t,j, r,t,f, p,t,j, l,x, r,x, w,f, r,f, s,t, j,t, s,p, k, s,c, i,f, s, f, pt, k, t,f, p,t,f, r,t, m, r, m |

b. TR# in Polish

| t,r, p,r, k,r, f,r, k,l, p,l, t,l, t,w, k,w, t,f, t,j, k,j, x,j, p,f |

Of the list of final TRs in Polish, [tw, kw] should probably be excluded as they involve past tense formation, while most of the forms ending in [tf, t,j, x,j] are also cases of some suffixation. Thus, in fact, final TRs are much more restricted than (3b) actually shows. However, this does not undermine the existence of such clusters in Polish.

Ignoring for the moment the possibility of having word-final consonant clusters with three or more members, we may conclude that in Polish final complex Codas are formally less restricted than the corresponding ones in

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8 Examples are: *gwałt* ‘rape’, *palt* ‘coat, GENpl.’, *czart* ‘devil’, *patent* ‘patent’, *matp* ‘monkey, GENpl.’, *skalp* ‘scalp’, *karps* ‘carp’, *pomps* ‘pump, GENpl.’, *hanb* ‘infamy, GENpl.’, *czył* ‘tank’, *wik* ‘wolf’, *targ* ‘market’, *bank* ‘bank’, *walc* ‘walz’, *sere* ‘heart, GENpl.’, *słoń* ‘sun, GENpl.’, *kształć* ‘educate, IMP.’, *zaparć* ‘constipation, GENpl.’, *miałec* ‘moan, IMP.’, *walcz* ‘fight, IMP.’, *tarchz* ‘shield, GENpl.’, *linicz* ‘lynch’, *kończ* ‘finish, IMP.’, *olch* ‘alder, GENpl.’, *parc* ‘scab’, *czeremch* ‘bird cherry, GENpl.’, *żółć* ‘turtle’, *barw* ‘colour, GENpl.’, *miast* ‘city, GENpl.’, *kosz* ‘cost’, *wysp* ‘island, GENpl.’, *slub* ‘service, GENpl.’, *kosb* ‘harvest, GENpl.’, *mózg* ‘brain’, *kośc* ‘bone’, *plaszc* ‘coat’, *nazw* ‘name, GENpl.’, *podeszw* ‘sole, GENpl.’, *szept* ‘whisper’, *fakt* ‘fact’, *ucz* ‘feast, GENpl.’, *Sierpc* ‘place name, GENsg.’, *zmięć* ‘soften, IMP.’, *depecz* ‘tread, IMP.’, *darn* ‘sod’, *urn* ‘urn, GENpl.’, *pokarm* ‘food’.

The list should perhaps also include *[jm, sm, sn, sw, cj, cl]* as in *piżm* ‘musk, GENpl.’, *pism* ‘document, GENpl.’, *blizz* ‘scar’, *pomyśl* ‘idea’, *piesń* ‘song’, *myśl* ‘thought’ (Cyran 2005), as they involve the infamous s+C clusters (Kaye 1992).

English, in that Polish allows not only for RT but also for TR clusters. Melodically speaking, the TRs are more restricted than RTs, which suggests that they are more marked in this context, or more complex in some way, to use our own terminology. In fact, we are dealing here with a well established markedness scale of possible shapes of the right edge of words in natural language which can be illustrated as under (4). Each level of formal complexity implies the presence of the less marked structure in a given system.

\[
\begin{array}{ll}
\text{(4) Markedness scale} & \text{Shape of the right edge of words} \\
a. \ldots VC_0 \# & \ldots CV \# \\
b. \ldots VC_1 \# & \ldots VC \# \supset \ldots CV \# \\
c. \ldots VC_2 \# & \ldots RT \# \supset \ldots VC \# \supset \ldots CV \# \supset \ldots TR \# \supset \ldots VC \# \supset \ldots CV \# \\
\end{array}
\]

Clearly, the implicational relationship between the shapes found at the right edge of words (TR\# \supset RT\# \supset C\# \supset CV\#) requires a formal explanation. But it also points to the fact that whatever happens to a single word-final consonant in this prosodically weak context is only a fragment of a larger picture. This is the main reason why the discussion of the effects of strong and weak contexts on consonantal melody is extended in this paper to clusters, that is, more complex formal configurations.

Recall that, typically, the discussion of lenition concentrates only on the situation in (4b) with respect to the weak environment _#, whereas (4b) is part and parcel of a more general formal scale of structures that can be found in this context, and may be affected by it. There are languages like (4a), in which words cannot end in a consonant (Italian, Zulu), that is, the context _# is unable to license any consonant. The next step in the formal complexity of the right edge (on the markedness scale) is the presence of a single consonant (Malayalam, Japanese). (4c) illustrates two systems with

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10 Words in Polish may also end with clusters of three, four and even five consonants, e.g. sióstr [custr] ‘sister, GENpl.’, lekarstw [lekarstf] ‘cure, GENpl.’, następstw [nastempstf] ‘consequence, GENpl.’. They are ignored in this discussion. See e.g. Cyran (2003) for an analysis of such words.

11 Note that both types of final clusters in Polish obey the melodic restrictions found in single final Codas, namely, they involve only voiceless obstruents and exclude palatalised labials.
two consonants in the complex final Coda. The less marked system has RT clusters only (English), while the more marked system may also have TRs (Polish). The implicational relationship between the two systems is that the presence of TRs implies the presence of RTs and not vice versa.

Interestingly enough, if we only take the melodic patterns of RT and TR and ignore the syllabic structure they are subsumed under, the markedness and implicational relationship TR# ⊃ RT# ⊃ C# observed in the word-final context is replicated in pre-vocalic contexts. The implication RTV ⊃ CV is referring to the existence of internal Codas, that is, the existence of branching Rhymes in the syllable structure of a given language. On the other hand, the relationship TRV ⊃ RTV, first noted in Kaye & Lowenstamm (1981), is most intriguing for a number of reasons. In syllabic terms, it refers to an implicational relationship between two theoretically disparate syllabic constituents, that is, a branching Onset (TR) and a branching Rhyme with a non-nuclear complement, that is, a Coda followed by an Onset of the following syllable (RT). This implication is difficult to express formally in any model, let alone expressing the obvious connection between the same tendencies observed in prevocalic contexts and word-finally.

In phonological models like Optimality Theory, the formal scale presented in (4) above seems to be easily handled by constraints. Namely, CV# is the least marked word edge as it does not violate any constraints on syllable structure. Syllables ending in C# are worse off because they violate the constraint *Coda. RT# violates *Complex Coda, and is therefore worse than C#. The problem begins when the relationship between RT# and TR# needs to be expressed formally. Additionally, an analysis that may work for the word-final context will fail to connect the tendencies with identical ones in prevocalic contexts, where TR is a branching Onset and RT is a Coda-Onset contact. The following section reviews some tendencies for single segments and clusters in various prevocalic contexts with a view to emphasising the parallelism between prevocalic and word-final contexts and suggesting a solution.
3. Distribution of consonants and clusters in prevocalic contexts _V

In this section we are going to look at distinctions of strength in two types of prevocalic contexts. For short, they will be referred to as pre-full vowel and pre-schwa contexts. It will be shown that to a great degree we are dealing with the same typology of possible consonantal melodies and cluster types in these contexts as word-finally, suggesting that the phonotactic patterns in _# are connected with prevocalic contexts. In fact, the respective contexts pre-full vowel, pre-schwa, and _# seem to form a non-arbitrary scale of relative strength in which the word-final context has a defined place and calls for a formal inclusion into an explanatory model of strong and weak contexts. Like in the previous section, melodic restrictions of single segments are compared with cluster distribution, although more attention will be paid to the formal complexity.

3.1. Malayalam Cə and CCə

It was mentioned earlier that Malayalam may have only one consonant in the word-final position. This language also has an interesting phenomenon of schwa epenthesis after a consonant or consonant cluster in that context. While a final sonorant may induce schwa epenthesis in informal style only, e.g. [wayara] ‘stomach’ vs. formal [wayar], final obstruents always involve schwa epenthesis, e.g. [kətalaasə] ‘paper’, [wiraka] ‘firewood’. Such phenomena are intriguing for any theory of syllable structure, especially for models referring to final Codas, because what is observed is that in a language with final Codas, segments, which for melodic reasons cannot be

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12 To be more precise, the contexts to be discussed are intervocalic, that is, VCV, VRTV and VTRV. However, the crucial distinctions we focus on lie in the nature of the following vowel, rather than the preceding one. This obviously excludes the left edge of words, a choice which will become more apparent in the theoretical section.

13 This does not mean that we suggest a unification of the phonological behaviour of such consonantal patterns with respect to phenomena typically associated with the notion of extrasyllabicity.
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licensed under this constituent, must become Onsets of the following syllable.\(^\text{14}\)

However, if the final consonant is of [+Sanskrit] origin and it is a complex obstruent, that is, involving laryngeal specification, then such stems, marked as [+Sanskrit], are treated by the language as bound morphemes and always appear affixed, i.e. a full vowel must follow these consonants, e.g. [laab^am] ‘profit’, [paat^ham] ‘lesson’, [ma^dam] ‘intoxication’ (Mohanan 1989: 622, Cyran 2001). Interestingly, the division between pre-schwa and pre-full vowel contexts, which is correlated with a particular distribution of consonantal melodies, is also reflected at the formal level, in that only RT clusters are found before a schwa, e.g. [paampa] ‘snake’, whereas TRs require a full vowel, e.g. [pa^ram] ‘letter’, just like the complex obstruents.

What Malayalam seems to show is that the distribution of single consonants in pre-schwa and pre-full vowel contexts is mirrored somehow in the distribution of cluster types. It is interesting, if not expected, that the more marked formal structure, that is a TR, requires a full vowel, which was also the case with the complex [+Sanskrit] obstruents, while the less marked RT cluster may be followed by a schwa, just as the simplex obstruents and complex sonorants. Recall that word-finally, no cluster is possible in this language and the melodic contrasts of single consonants in this position are limited to sonorants. Thus, we seem to observe an interesting scale of relative contextual strength, which we can represent as under (5) below. This scale refers to the melodic distribution in single consonants and to clusters.

\[
\begin{array}{ccc}
\alpha & \omega & # \\
\text{C}_a & \text{C}_b & \text{C}_c \\
\text{RT} & \text{RT} & \\
\text{TR} & \\
\end{array}
\]

\(^{14}\) Particularly interesting are the register differences between the informal [wayar] ‘stomach’ and formal [wayar]. The final Coda view imposes two different syllable, and hence, word structures for these forms.

\(^{15}\) The symbol ‘\(\alpha\)’ will as of this point be used to denote a full (unreduced) vowel.

\(^{16}\) \(\text{C}_a\) = all possible consonants, including [+Sanskrit] complex obstruents, \(\text{C}_b\) = all Malayalam obstruents and sonorants, \(\text{C}_c\) = [m, n, \(\eta\), l, r].
The scale should be read in the following way. The word-final context is the weakest in terms of licensing both the segmental material of single consonants and clusters. In fact, no cluster is allowed in this context. The next context is that before a schwa vowel, which also imposes some melodic and formal conditions on the preceding consonantal material, but it is stronger than the word-final one. Thus the relative strength of the three contexts is reflected in the amount of consonantal structure that can be licensed both melodically and formally speaking.¹⁷

The status of schwa in this scale is symbolic, and simply means that it represents a ‘prosodically weaker context than a full vowel’. A precise definition of schwa for the purpose of this scale is a matter of further research. What is important here is the functional distinction between the strong prevocalic and weak prevocalic contexts, a difference which often coincides with melodies of full vowels and schwas respectively. The melodic definition of the ‘pre-schwa’ context is sufficient for Malayalam. However, in languages with no vowel reduction in unstressed nuclei, in which the context ‘before unstressed vowel’ curtails the distribution of segments and clusters, the distinction __α vs. __≠ may need to be defined in prosodic terms, that is, referring to the distinction ‘before a stressed / unstressed vowel’, and without referring to the melodies of the vowels.

The phonetic schwa may either be a result of epenthesis, as in the case of Malayalam, or it may be a result a vowel reduction in unstressed positions.¹⁸ What matters is that the schwa is a weaker licenser than a full vowel. At the same time, it is prosodically stronger than __≠. It must be emphasised that the ‘strong’ vowel is represented symbolically as well. Hence the use of the symbol α. Its strength is always relative with respect to __≠ and __≠. The melodic distinction between strong vowels and schwa is not used in all languages. Polish, for example, has no vowel reduction, but it also does not show a noticeable difference between the prevocalic contexts depending on whether the vowel is stressed or not. It is a matter of further research to see if the absence of this melodic distinction necessarily entails the absence of the distinctions in strength.

The pre-schwa context may be formally defined in various ways. This is the context of, for example, the intervocalic weakening of single conso-

¹⁷ It must be admitted that all three contexts presented in (5) refer to the right edge of words in Malayalam, in that __≠ is a case of epenthesis after underlying final consonants and clusters, while __α stands for cases of –am affixation.

¹⁸ See e.g. van Oostendorp (2000) for various distinctions among schwa vowels.
nants. In order to illustrate the purely functional understanding of the pre-

schwa context that is used in this paper, let us recall some familiar facts from English. In this language an intervocalic /t/ may be subject to lenition if the following vowel is unstressed – a schwa type, in our understanding. For example, the /t/ in city may be tapped or glottalled as in [sɪər] and [sɪəɾ] (Harris 1990: 285). Such lenition is banned in pre-stress position. The word settee [sətɪː], with stress on the second vowel, cannot be pronounced as *[səɾiː] or *[səɾiː]. Let us now turn to the correlation between the distribution of cluster types and the two prevocalic contexts. We will look at two languages, Irish and Dutch.

3.2. Stress-related metathesis in Irish

Irish exhibits an interesting phenomenon of metathesis which appears to be stress related. Consider the following data taken from Munster Irish (Sjoestedt 1931, Ó Cuív 1975, Ó Siadhail 1989, Ó Sé 2000), in which the position of the liquid may change within the word.

   b. [bəɾˈlaɲ] brollach ‘breast’
   [bəɾˈkoɲ] brocach ‘grey’
   [bəɾdəːn] bradán ‘salmon’

The data under (6a) show an alternation which is effected by the shift of stress onto the suffix –ach, a particular feature of Munster Irish. Metathesis is also found in forms with no alternation (6b), which are, however, also caused by the –ach sequence, or by regular stress attraction to a long vowel in a configuration V–VV, e.g. bradán.21 We know these are metathesised forms because they are optional variants of the existing non-metathesised forms, e.g. [brədəːn], [bɾəkɔɲ], [bɾəlæx].

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19 Within the general Government Phonology paradigm, there are different definitions of that context. Compare, e.g. Ségéral & Scheer (this volume b) and Harris (1997).
20 For a foot-based analysis of t-lenition in English see e.g. Harris (1997).
21 If all the vowels in this word were short then stress would fall on the initial syllable (Gussmann 1997).
What is interesting for us is that the effects of metathesis observed in (6) show a peculiar preference for RT clusters, and therefore internal Codas, at the expense of complex word-initial Onsets TR → RT. If this observation is correct it poses serious problems to any syllabic theory, as it is very difficult to express the relationship between Branching Onsets (TRs) and internal Codas, that is, RT clusters, especially that the crucial aspect of this relationship, that is, stress on the following vowel, is located outside that syllable, e.g. *bradach* [bǝrdax] ‘thieving, NOMsg.’ Clearly there is a relation between the placement of stress and the direction of the liquid shift. TR survives if the following vowel carries stress (TRαΤα). However, if the second vowel is stressed, then the word-form is optionally ‘repaired’ by metathesis, whereby an RT cluster is formed next to the stressed vowel (TRσΤα → ΤσRTα).22

Thus, a TR cluster is better off in front of a stressed vowel, and it may be eliminated if it finds itself in front of a schwa. More importantly, Irish points to a possible relation between an RT cluster and the following vowel – some conditioning of branching Rhymes is located in the following syllable. Below we will look at facts which demonstrate the relationship between RT and TR clusters and the type of the following vowel in a more obvious way. The picture will also involve the third context under discussion, namely _#. This final set of data will be followed by a hypothesis as to the nature of the word-final context.

3.3. Dutch clusters and the scale of contextual strength

We begin the discussion of Dutch with the pre-schwa context of the contextual strength scale (_α > _σ > _#). Among the many characteristics of the schwa vowel in Dutch, the one which is most interesting for us is its constrained distribution with respect to preceding clusters.24 Kager (1989: 212) notes that pre-schwa clusters in Dutch behave as if they were word-final. In other words, schwa behaves as if it was a word boundary (_σ = _#)
rather than a Nucleus which is able to construct its own syllable. What is surprising in this observation is that consonants or clusters in word-final position are typically treated as Codas or complex Codas respectively in standard generative (and even current Optimality) frameworks. On the other hand, pre-schwa consonants and clusters, in most languages and in most theories, constitute a variety of structures, namely, an Onset if it is a single consonant (...Cα), a branching Onset if it is a cluster of rising sonority (...TRα), and a Coda-Onset contact if it is a cluster of falling sonority (...RTα), but never a complex Coda.

In what follows, we will look at both rising and falling sonority clusters in all three contexts, that is, _α, _α, _#, and suggest that the observed patterns are not at all accidental. First, we take clusters of increasing sonority (TR), that is, branching Onsets. Such clusters are said to occur only before full vowels (Kager 1989: 212).

(7) a. TR# b. TRα c. TRα
* [katr] *[ka.trol] [ka.trol] katro\textsuperscript{l} ‘pulley’
* [dypl] *[dy.plα] [dy.plα] ‘duplicate’

There are no word-final clusters of rising sonority (7a), or before a schwa vowel (7b). TRs in Dutch require a full vowel to follow as shown in (7c). This reminds us of the situation found in Malayalam and Munster Irish, discussed in the preceding sections.

However, it is not true that (7a) and (7b) are equally unacceptable. While there are no word-final clusters of rising sonority in Dutch, one can find a few interesting exceptions to the pre-schwa context. First of all, there is a well-defined group of words, mostly of Greek origin, where clusters of rising sonority do occur before a schwa, although, admittedly, these clusters do not look like well-formed branching Onsets, e.g. * [dafnα] (Kager 1989: 213). Secondly, well-formed branching Onsets are found in pretonic position in words like fregat [frαgat] ‘frigate’, brevet [brαvεt] ‘patent’. It is an interesting question why a pretonic schwa is a better licenser than other schwas. Note that melodically we are dealing with identical objects. Clearly, the difference lies in their prosodic function, which is exactly what is emphasised in this discussion. A possible reason for pretonic schwas being stronger licensors might be that in forms like [frαgat] and [brαvεt] it is the head of the foot, albeit the weak one, while other schwas are not heads but complements of their feet.
Given the above exceptions to the restriction *TRα, it appears that we are rather dealing with a sort of gradation of acceptability of clusters in the three contexts in (7); from absolutely excluded (_#), through highly restricted (_α), to fully acceptable (_α). This scale is presented below in a symbolic way in order to facilitate the comparison of the restrictions on clusters of rising sonority with those of falling sonority, to be presented below.

\[(8)\] \(^{\text{de}}\text{TR}_\alpha > *^{\text{de}}\text{TR}_\alpha > *\text{TR}#\]

This hierarchy should be read as follows: a full vowel is a cluster-friendly context and licenses better than schwa, which in turn is only a slightly better licenser than #, which does not license TRs at all.

Before we begin discussing the distribution of RT clusters in the same three contexts, it should be reminded that earlier we observed an implicative relationship between the TR and RT clusters to the effect that TR implies RT. Using the licensing vocabulary, this implication means simply that RTs are easier to license than TRs. The obvious question is why they are easier, a point to which we return in the theoretical part of this paper.

With respect to the pre-schwa clusters of falling sonority Kager (1989: 214) makes a similar claim, namely, that the schwa vowel behaves like a word boundary (#). However, the restrictions and effects are markedly different from what we observed with respect to TR clusters. First of all, the word-final context does not totally preclude RT# clusters, as was the case with *TR#. There are two types of RT clusters which are grammatical in that position, namely, homorganic nasal-stop and sonorant-dental sequences.

\[(9)\] a. [damp] \textit{damp} ‘vapour’ b. [χert] \textit{Gert} ‘first name’
[danłk] \textit{dank} ‘thanks’ [boelt] \textit{bult} ‘hunch’
[avɔnνd] \textit{avond} ‘evening’ [vers] \textit{vers} ‘fresh’

In the first set, the existence of these partial geminates may be accounted for by referring to the integrity of such structures (e.g. Hayes 1986). As for the dental obstruent in (9b), it may be treated as an appendix or an extrasyllabic consonant in order to account for these forms (Kager & Zonneveld 1986). However, the homorganicity that is involved in both data sets suggests that a uniform analysis needs to be sought for these forms, preferably one which does not refer to extrasyllabic or appendices. For
our purposes, however, the interesting observation concerning the data in (9) is that RT clusters are not entirely excluded from word-final contexts. Recall that no such exceptions were found in word-final clusters of rising sonority, that is, TRs (7).

Clusters made of a liquid and a non-dental consonant are different in that they are subject to schwa epenthesis in two contexts: at the end of the word (syllable) and before a schwa (Kager 1989: 214). Thus, once again the pre-schwa situation is identified with the end of the word. However, the status of the epenthesis in the two contexts is again not identical. While epenthesis is almost obligatory in the word-final context (10a), it is only optional and stylistically conditioned in pre-schwa position (10b). It is, however, excluded in the context preceding a full vowel (10c).

What we observe in (10) is a gradation of RT integrity depending on what follows the cluster, which is reminiscent of the restrictions on TR clusters in (8), but also of the relationship between TR and RT clusters and the type of the following vowel observed in Malayalam and Irish.

The word-final context in (10) seems to be an integral element on the scale of contextual strength. Recall, however, that formally speaking RT# is a final complex Coda, while RTσ and RTα are Coda-Onset clusters in a
variety of theoretical models, which makes our observationally established scale of contextual strength difficult to express formally.

Another interesting problem that is difficult to capture in standard syllable theories is the motivation for the optional epenthesis in (10b). Note that in the words like *karper* ‘carp’, the choice is between a branching Rhyme containing an internal Coda, followed by an Onset of another syllable, that is, an RT cluster [kar.por], or a resyllabified structure with no branching Rhyme [karəpor]. Here, an analysis which might refer to internal Coda avoidance would fail to respond to the obvious fact that the choice involving the optional epenthesis is clearly connected with the following schwa, in that either it is considered a good licensor for the RT cluster or not. Thus, whether a branching Rhyme is possible or not appears to be decided upon in the following syllable, as it were, and not in the syllable that is supposed to contain the Coda in question.25

Thus, on the one hand, the distribution of RT clusters in Dutch reflects exactly the same contextual scale (_α > _ə > _#) which was observed in the distribution of TRs. On the other hand, the same markedness relationship is observed between RT and TR clusters as in other languages. The crucial fact concerning the distribution of RT and TR clusters in Dutch is that, in each respective context which is weaker than a pre-full vowel, RTs fare better than TRs. The scale in (11) shows the relative preferences concerning TRs and RTs in the relevant contexts.

\[
\begin{array}{c|c}
\text{Preferred} & \text{Dispreferred} \\
\hline
\text{okTR} & \text{optional epenthesis} RT \\
\text{okRT} & \text{obligatory epenthesis} ok \\
\text{TR#} & *TR# \\
\end{array}
\]

Recall that the question why RT# is less restricted than TR# may be explained by the Sonority Sequencing Generalisation (SSG) which says that word-final consonant clusters are complex Codas and they must decrease in sonority. Thus, the string Nucleus+RT# complies with the generalisation, whereas Nucleus+TR# does not. However, as it stands, the SSG provides

25 Recall that Irish metathesis in §3.2 really showed the same dilemma connected with syllable structure, even if the details were slightly different. Namely, the metathesis of the type *[brədɪg]*/[bɔɾ'doχ] bradaigh / bradach ‘thieving, GENsg./NOMsg.’ points to a preference for the internal Coda at the cost of the complex Onset in the same syllable. But, interestingly, the shifts are also connected with a variation of strength in the following syllable.
no platform for comparison between the word-final, pre-schwa, and pre-full vowel contexts, and the hierarchy of contextual strength makes very little theoretical sense to SSG. Firstly, it is a mixture of contexts, where two are pre-vocalic and one is not. Secondly, and this point is connected with the first one, if it is a non-uniform set of contexts then the hierarchy they form is accidental. Re-ranked scales, where the word-final context features between full vowels and schwas *(\(\_\alpha\) > \(\_\#\) > \(\_\dot{\sigma}\)), or is even allowing for more than full vowels *(\(\_\#\) > \(\_\alpha\) > \(\_\dot{\sigma}\)), can only be excluded on observational and not on theoretical grounds.

It appears that all these theoretical problems may disappear once an assumption is made that in a sense reverses Kager’s claim concerning the affinity between pre-schwa and word-final contexts. Specifically, maybe it is not the case that Dutch schwa behaves like a syllable boundary, but the reverse – the word-final context behaves as if it was vocalic in nature. However, since no vocalic melody is present there, we may assume that \(\_\#\) is in fact a context before an empty Nucleus.\(^{26}\)

This assumption, which will be further illustrated in the following section, solves two problems described above. Firstly, TR and RT clusters before a final empty Nucleus are now formally identical to the same clusters in pre-schwa and pre-full vowel contexts. TRs are always branching Onsets, as it were, and RTs are Coda-Onset sequences in all three contexts. Secondly, the scale of contextual strength receives a non-arbitrary explanation now. In the scale \((\_\alpha > \_\dot{\sigma} > \_\dot{\varnothing})\) a full vowel licenses better than a prosodically weaker schwa. Both schwa and the final empty Nucleus are weak licensers, but schwa has melody and is therefore a better licenser than the empty Nucleus. Recall that the contextual strength expressed by the licensing scale relates not only to consonantal clusters but also to single segments. The theoretical difference between the contexts \(\_\#\) and \(\_\dot{\varnothing}\) is illustrated below in (12).

\[
(12) \quad \begin{array}{ccc}
\text{context} & \text{effect} & \text{licensing scale} \\
\text{(traditional)} & & \\
\_\alpha & \text{unmarked, no restrictions} & \_\alpha \\
\_\dot{\sigma} & \text{more marked, some restrictions} & \_\dot{\sigma} \\
\_\# & \text{most marked, severe restrictions} & \_\dot{\varnothing} \\
\end{array}
\]

\(^{26}\) Arguments in favour of this hypothesis can be found in, for example, Harris & Gussmann (1998), Kaye (1990) and Scheer (2004).
As mentioned above, the contexts in (12a) do not constitute a uniform set, and the placement of # at the bottom of the markedness hierarchy is arbitrary and based only on observation. On the other hand, the scale of licensors in (12b) leaves no space for re-ranking. An empty Nucleus cannot license more than a schwa, and a schwa cannot license more than a full vowel.

3.4. The story so far

In the above sections we tried to demonstrate that the distribution of single consonants in contexts of varying licensing strength is but a fragment of a bigger picture in which consonant clusters must also be included. A rough scale of substantive / melodic complexity was proposed in (2) in order to show how the effects imposed by strong and weak prosodic positions can be translated into licensing of structure. Generally, the more structure that needs to be supported by licensing, the more likely it is that segmental effects occur in the respective weak positions.

The relative licensing strength of particular contexts seems to form a scale which has eventually been identified as pre-vocalic, or more precisely, pre-nuclear (α > å > ø), as the empty Nucleus – the weakest licenser – does not sound like a vowel, and corresponds to the right edge of the word. The identification of all three contexts as one type, that is, pre-nuclear, allows us not only to understand the specific place of # at the bottom of the scale, but also makes the comparison of the distributional tendencies of consonantal structure more uniform. Namely, a single consonant in pre-nuclear positions is always an Onset, rather than an Onset in Cα and Cå, but a Coda in C#. Likewise, the comparison of the distribution of RT and TR clusters in the respective contexts makes more theoretical sense now, as they are always of the same syllabic configuration. RTs are always Coda-Onset contacts, e.g. Dutch harpun [har.pun] ‘harpoon’, culte [koel.tå] ‘cult’, damp [dam.p] < /dam.pø/ ‘vapour’. TRs, on the other hand,

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27 For reasons of space and clarity, we ignore another important prosodically weak context, namely, the internal Coda. Note that this position is identified with the first consonant of the RT clusters discussed here. For two disparate formal accounts of this context see, e.g. Harris (1997) and Ségéral & Scheer (this volume b).
are always branching Onsets, e.g. Polish *wiatru [v jatru] / wiatr [v a.tr] < /v atrø/ ‘wind, GENsg. / NOMsg.’.

The markedness relationship between RT and TR clusters has been shown to require a different perspective as well, that is, one which takes into account the dependence of both types of clusters on the type of the following Nucleus, the licenser. We may illustrate the shift in focus by the following diagram in which the dotted area illustrates the traditional way of looking at syllabic constituents, while the solid-line area marks the domains of interaction that transpire from such facts as the distribution of clusters in Malayalam, Irish metathesis and Dutch epenthesis.

This way of looking at syllabification through a prism of syllabic constituents is unable to express the relationship between TR and RT clusters because RTs are not a syllabic constituent but a Coda-Onset contact. The comparison that can be made in this traditional approach is one between a branching Onset and a branching Rhyme (Kaye & Lowenstamm 1981). On the other hand, the empirical facts reviewed suggest that for each type of cluster it is important what type of Nucleus follows, that is, TRα/ø/ø and RTα/ø/ø.

In the following section, an attempt is made to provide a theoretical model that would take into account the above observations.

4. Complexity Scales and Licensing

The theoretical model, called Complexity Scales and Licensing (CSL), is a combination of a number of slightly reformulated tenets of Standard Government Phonology (GP) (Kaye et al. 1990, Charette 1990, Harris 1994, 1997) with the CV hypothesis (Lowenstamm 1996), which now has a
number of developments. CSL retains the basic Standard GP assumption about bidirectional governing relations between consonants, but it does not make a meaningful reference to constituents such as branching Onsets, Rhymes or Nuclei. The version of CSL presented in this paper will in fact not take a stand as to whether word structure has maximally branching syllabic constituents, or whether it is built on the CVCV template. Most of the predictions of CSL are compatible with both views, therefore, the presentation will abstract away from concrete structures.

The principal interest of CSL lies in discovering scalar effects at the substantive (melodic) and formal (syllabic) levels, where the scales follow from the principles defining phonological representation and are non-rerankable in character. These representational scales of growing complexity interact with the licensing potential of different types of Nuclei (scale of licensers). Thus, the complexity of structure, in a sense, gauges the licensing strength settings for a particular system. In other words, the presence of particular substantive or formal configurations in the word structure of a given language directly indicate the strength of the currency, called licensing (Cyran 2003).

4.1. Licensing

Like in many other approaches, GP assumes that vowels / Nuclei constitute an indispensable element of syllabification. Nuclei are special because of their role in prosodic organisation, that is foot and word structure, but also due to the fact that generally words without Nuclei cannot exist. In this respect, Nuclei are assumed to be the carriers of prosodic information in the phonological representation. It is through Nuclei that the prosodic licensing is distributed within the phonological word (e.g. Harris 1997). The lowest level of this licensing is that between a Nucleus and its Onset.

(14)  

Each Nucleus must license its Onset, a relation which encapsulates three crucial aspects of syllabification. Firstly, it directly reflects the supremacy

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of Nuclei within the structure of words. They are indispensable because
they are the licensers. Secondly, by recognising the existence of the licens-
ing relation between the Nucleus and the preceding Onset (and not the fol-
lowing) we are able to account for basic syllabification without resorting to
additional principles such as Onset Maximisation. And thirdly, the absence
of such licensing, or weakened licensing, has a direct influence on the pre-
ceding Onset.

The absence of licensing results in the absence of consonantal melody
in front of such a Nucleus. This situation relates, for example, to the ab-
sence of word-final consonants. Languages like Italian do not assign any
licensing potential to final empty Nuclei, and hence words may not end in a
consonant in such systems. Weakened licensing, on the other hand, is re-
sponsible for the restricted distribution of single segments, as observed in
pre-schwa and pre-empty Nucleus contexts in Malayalam, or in the lenition
of single segments, e.g. final devoicing in Polish, or t-lenition in English.
As we saw in the discussion of consonants in word-final position in §2.1,
the typology and markedness in this context is a reflection of the interac-
tion between the licensing strength of the particular context, which is set
individually in languages, and the melodic / substantive complexity of
consonantal segments.

Recall that weak licensing will also have influence on the distribution of
RT and TR clusters and will be responsible for weakening processes such
as, for example, epenthesis, metathesis, or cluster simplification by dele-
tion. To be able to see how licensing supports clusters, first they have to be
defined formally.

4.2. Government

A cluster in CSL is a sequence of two consonants which contract a govern-
ing relation.\footnote{There are surface sequences of consonants which do not contract any govern-
ing relation. These are called bogus clusters, e.g. [tl] in atlas, and will be kept
aside in this discussion for reasons of space.} Like in Standard GP, and many other currently entertained
versions of this model, this type of segment interaction determines syllabi-
fication, i.e. the arrangement of segments into well-formed words (phonotactics). Government is an asymmetrical relation and depends on a number of conditions.
(15) a. *melodic complexity* (in which the governor, symbolised as (T), is melodically more complex than the governee (R)).

b. *adjacency* (two consonants must be adjacent in the relevant sense).  

c. *licensing* (governing relations, just as simplex segments, require licensing from the Nucleus following such a segment or relation).

In our discussion of government, we concentrate on interconsonantal relations only. This relation may to some extent be viewed as a binding mechanism which extends the domain of licensing. In other words, government, though ontologically different from licensing, is *de facto* forming structures bigger than one segment whose individual players exist due to a single source of licensing – the Nucleus that directly follows the second consonant. This will be illustrated under (16) below.

The use of the symbols T-governor and R-governee in (15a) above is not accidental, as the governing properties of segments typically correspond to the division T-obstruent vs. R-sonorant. However, the precise calculation of governing properties of a given segment is done on the basis of the complexity of its internal structure relative to the complexity of the neighbouring consonant. Complexity to a great extent corresponds to the familiar sonority scale, though it is rather the inverse of sonority: the more complex a segment, the less sonorous it is (2). It is also possible that a sequence of two sonorants or two obstruents forms a governing relation. This will structurally correspond to a Coda-Onset governing relation, and will be represented as RT, rather than RR or TT (for example *film* /fɪlm/, *act* /ækt/).

Adjacency (15b) also requires a word of comment, as it will be defined differently depending on whether we assume binary constituent structure or the CVCV format. In the former case, adjacency can be defined at the skeletal level (Kaye *et al.* 1990), while in the latter it must be defined either at the projection of Onsets, or at the melodic level.

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30 Typically, next to *adjacency* Standard GP mentions *directionality*, which determines whether we are talking about constituent or interconstituent government. In this paper, directionality does not have any particular theoretical status, as no meaningful reference to constituents is made.

31 Internuclear government is also recognised in most varieties of GP. It is, for example, made responsible for vowel – zero alternations, as in Polish *sen* /snu* [sen /snu] ‘dream, NOMsg./GENsg.’ (Gussmann & Kaye 1993, Scheer 2005).
A few questions may arise in connection with the conditions listed in (15). Firstly, it must be clarified what happens if all these conditions are fulfilled, and what happens if one of them is not. If all conditions are met, we are not dealing with the mere possibility of contracting a governing relation, but with a requirement. If government is to make any sense in phonological theory, its occurrence must be assumed to be automatic, and therefore obligatory in all conducive contexts. On the other hand, a failure to fulfil one of the conditions in (15) precludes government.32

We will now concentrate more on the last condition mentioned in (15c), and illustrate how clusters are licensed.

4.3. Licensing of clusters and the formal complexity scale

The entire cluster is licensed by the following Nucleus. Let us look at the only two types of governing relations that the theory proposes, which are illustrated in a simplified way below for the words *clench* and *bulky*.

(16) a. T R V ... b. ... R T V
   |    |   |             |     |   |
   k l e n ĭ | b l k

Regardless of the linear order in which the adjacent segments /k/ and /l/ find themselves in a string, the direction of the governing relation may only be that from the obstruent to the sonorant. The rightward relation corresponds to the traditional concept of the branching Onset, while the leftward relation defines Coda-Onset contacts. Note that at this stage we are already able to express the phonotactics within branching Onsets and in syllable contacts by means of a uniform mechanism, namely government, which produces the melodic patterns elsewhere referred to as the Sonority Sequencing Generalisation.

32 The absence of government does not automatically preclude surface consonant sequences. The so-called bogus clusters as in *atlas* /ætələs/ differ from governing relations in that the first member is licensed by the intervening empty Nucleus. Logically, if that empty Nucleus is unable to license its onset in a given language, then bogus clusters are disallowed.
The illustration under (16) shows how TR and RT clusters are related to the following Nucleus, a relation which is independent of the constituent structure, as signalled in (13). The primary function of Nuclei in phonological strings is to license their Onsets. These Onsets, however, may find themselves in different configurations and each configuration requires different degrees of licensing strength from the following Nucleus. Thus, formally speaking, we are dealing with three levels of complexity, each of which poses different demands on the licenser. For a single consonant, the licensing strength requirement depends on the internal / substantive complexity of the segment. On the other hand, the two types of governing relations, that is RT and TR, are clearly more demanding on the licenser, as this time two consonants are licensed (see (16)).

The question is how TRs can be shown to be more demanding than RTs, as this would correspond to the markedness relationship between these two types of clusters. The answer to this problem seems to have existed within GP for some time, and refers to a long-standing distinction between direct and indirect government licensing (Charette 1992: 289). Government licensing is a special form of licensing where the preceding Onset is involved in a governing relation. In this sense, government licensing is not much different from normal licensing, but it is a stronger version of it, as it licenses more complex formal structures. It is easier to license simplex onsets than governing relations. On the other hand, as regards the two types of government licensing, RT clusters are easier to license than TRs because the head of this governing relation is directly adjacent to the licenser, while in TRs the licenser is removed from the head by the intervening governee. This distinction may also be used to account for stricter requirements as to the sonority distance in TRs in comparison with RTs. Because TRs are more difficult to license, formally speaking, they must form ‘easy’ governing relations substantively speaking, that is, ones in which the complexity / sonority differential between the governor and the governee is greater.
(17) illustrates the formal differences between particular configurations of Onset licensing. (17a) represents the simplest arrangement, where a Nucleus directly licenses a simplex Onset of any substantive make-up. (17b) and (17c) are formally more complex structures because the Onset, which receives licensing from its Nucleus, is itself in a relation with another consonant, thus extending the domain of licensing. However, in RTV the Nucleus is directly adjacent to the head, while in TRV it is not.

This formal difference should suffice to establish the relative markedness of the structures in (17). Note that the syllabic complexity scale, which is derived from government and licensing, corresponds to the levels of markedness proposed by Kaye & Lowenstamm (1981). They observed an implicational relationship that seems to hold cross-linguistically between branching Rhymes and branching Onsets, that is between RT and TR clusters in forms such as *vulgar* and *co.bra*. The observation stipulates that a language which has branching Onsets (TRs) must also possess in its syllabic inventory the structure of a branching Rhyme (RTs). The implication cannot be reversed, and this fact follows directly from the above scale of progressively marked structures, each of which makes a progressively growing demand on the licenser.  

Recall that traditional syllable theories find it difficult to express the implicational relation between TRs and RTs because the former is a branching Onset and the latter is a Coda-Onset contact. Thus, there is no obvious theoretical means to capture this relationship. In CSL, as evident from (17), the common formal denominator in establishing the complexity scale is the fact that in each instance there is a licensing relation between an Onset and the following Nucleus. Thus, the deciding factor in systemic decisions as to how much syllabic structure is to be allowed can be reduced to one theoretical aspect of phonological organisation: the licensing properties of Nuclei, or better, the **licensing strength** of Nuclei. This tallies neatly with the empirical facts reviewed in §2 and §3, namely, that there is an intimate relationship between the distribution of RT and TR clusters and the type of the Nucleus that follows these structures.

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34 It must be noted that the complexity scale based on licensing demand makes correct predictions about word-medial and word-final contexts. However, it fails word-initially where #TRs are less marked than #RTs. An attempt to solve this problem is made in Cyran (2003). However, a non-arbitrary account of the left edge in CSL is yet to be achieved.
The selection of the actual strength of Nuclei in a given language is arbitrary, that is, either of the three choices (I–II–III) is available, but the scale itself is by no means arbitrary. The three markedness levels, or ‘quantal regions’, to borrow a term from phonetic theory, along the scale of syllabic complexity are non-reversible or re-rankable. They are also in an implicational relationship.

The fixed nature of the complexity scale – allowing for easy falsification – is not its only advantage. Notably, the simplex Onset is at last treated as a genuine part of syllabic markedness, rather than an implied structure in the presence of more complex situations. It is where the scale begins, and thus it plays the role of a crucial reference point. The scale also offers a fresh look at the concept of markedness itself. More complex structures need not be viewed as violations of any universal conditions or constraints; rather, they use all logically possible structural configurations, some of which happen to be more costly to license than others. In this respect, complexity and markedness are synonymous terms.

We are now ready to discuss the problem of consonant clusters in strong and weak positions.

5. **Consonant clusters in strong and weak positions**
5.1. **Syllabic ‘space’ in CSL**

Languages make, to some extent, arbitrary choices as to how much they allow their Nuclei to license. The possibilities are selected along a scale, where the licensing potential is commensurate with the complexity of the licensed structure. The structural complexity is defined by the presence and type of government (17). At level I, there is no government present and only the internal structure (substantive complexity) is responsible for gauging the licensing demand. Levels II and III are instances of leftward and rightward government, which correspond to RT and TR clusters, respectively.

Intersecting with the formal complexity regions in (17) is a scale of licensing strength (\( \alpha > \_a > \_o \)) (12). The empty Nucleus plays a pivotal role in the hierarchy of licensors but, more importantly, its presence in the model affords a fresh view on word-final consonants: these may be viewed as Onsets and can be integrated into the system of preference scales in a straightforward fashion.
The above scheme encapsulates a number of aspects connected with syllabic space, the occurrence of consonant clusters and their fate in various prosodic positions. Note that both vectors reflect implicational relationships. The vertical one relates to structure, in that the presence of the more complex / marked structures implies the presence of the less complex ones. Hence, TR implies RT and not vice versa. RT implies C, but C is also implied by TR, by transitivity. On the other hand, the presence of a given structure licensed by a weaker licenser implies the presence of the same structure if the licenser is stronger. Thus, for example, TRø implies TRα and TRα.

The syllabic space can therefore be defined as the effect of interaction between the vertical, formal complexity scale which is very much connected with the presence of government and its type, and the horizontal scale of licensing strength. It must be emphasised that both vectors are maximally expanded under (18). In other words, the syllabic space is finite because it is defined by government: the adjacency of government precludes going beyond level III of syllabic complexity.

Likewise, the horizontal vector of licensing strength under (18) is also maximally expanded. There is no better licenser than a full stressed vowel, and no worse licenser than an empty Nucleus. In fact there is one configuration which is even more marked than the word-final branching Onset. It is a combination of a word-final branching Onset and a preceding Coda consonant, in which case the final empty Nucleus has three consonants to support because the governor binds two complements. This configuration does not violate the principles of government and licensing, as government is bidirectional, and adjacency is respected. Polish obliges us with an illustration of this situation in, for example, sióstr [custr] < /cus t → rø/ ‘sister, GENpl’, or mantr [mantr] < /man t → rø/ ‘mantra, GENpl.’. Note that this structure is a combination of RT and TR. Naturally, word-final RTR is
even more restricted melodically than final branching Onsets in Polish. Only a handful of examples can be found.

5.2. Markedness, typology and learnability

This section briefly mentions three aspects falling out of the syllabic space defined in (18), that is, markedness, typology and learnability of syllable structure.

The least marked, and therefore the most preferred situation, is one in which a simplex Onset is licensed by a melodically filled, unreduced vowel. Languages which do not go beyond that configuration exhibit no consonant clusters or word-final consonants. Moving away from the $\text{C}_{\alpha}$ situation either down the complexity scale or along the licensing scale renders the corresponding structures more marked and predicts the possibility of defective distribution. This fact is represented in the scheme in (18) by means of the curve. Anything above the curve is ‘better’ than what is found under the curve. The curve also expresses the fact that a given type of licenser can license the same amount of structure as the next stronger licenser, or less structure, but never more structure.

In theory, we must allow all types of licensing to sanction all types of possible structures. This means that at the opposite end of the ideal situation, that is CV, where the vowel is melodically filled, we may find a TR cluster (level III of structural complexity) licensed by an empty Nucleus, the weakest licenser. It is the most demanding configuration from the point of view of the interaction between structural complexity and its licensing. Word-final branching Onsets are found in languages like Icelandic, French, or Polish.

Typologically speaking, languages will simply differ in their arbitrary choice of licensers and the types of formal configurations that these licensers will sanction. To use Polish as an example, there are only two types of licensers: full vowels and empty Nuclei. Both types of Nuclei can license all three formal configurations as illustrated below.

(19) Polish

a. $\text{C} \rightarrow \alpha/\emptyset$  

b. $\text{R} \rightarrow \text{T} \rightarrow \alpha/\emptyset$

c. $\text{T} \rightarrow \text{R} \rightarrow \alpha/\emptyset$

\begin{tabular}{lll}
\text{mata} & ‘mat, N.sg.’ & \text{warta} & ‘worth, fem.’ & \text{wiatr} & ‘wind, G.sg.’ \\
\text{mat} & ‘ibid, G.pl.’ & \text{wart} & ‘ibid, masc.’ & \text{wiatr} & ‘ibid, N.sg.’
\end{tabular}
Structurally, word-final consonants and consonant clusters do not differ from those in pre-vocalic position, with the expected exception that they will be of narrower melodic scope. For example, there are a few contrasts that cannot be maintained before final empty Nuclei, such as voicing of obstruents and palatalisation of labials (§2.1).

Other languages, like English, may use all three types of licensers. Note, however, that in English words cannot end with TR clusters, which means that empty Nuclei are not granted the licensing strength to sanction the last level of syllabic complexity (III), while RT clusters (level II) are possible, e.g. belt, bump, etc. Italian grants no licensing power to final empty Nuclei and must end its words with a vowel, while Japanese and Malayalam allow for licensing only simplex Onsets word-finally.\(^{35}\)

One might also consider the potential role of this model in language acquisition. The acquisition of syllable structure consists simply in extending the two vectors away from the basic CV shape, thus increasing the ‘syllabic space’. What needs to be assumed, however, is that the learner works out the existence of government and licensing somehow. Given this assumption, phonological structure is induced on the basis of positive input, that is, each input tells the child what is possible, rather than what is not. Secondly, a minimal amount of input allows the child to induce the presence of other less complex / marked structures by simple implication.

To exemplify the last two points let us assume, quite naively, that the child is genetically equipped with the model illustrated in (18). Generally, what the learner knows are two scales of implicational relationship. One of them relates to the formal complexities (I \(\subset\) II \(\subset\) III): it says that TR clusters imply the presence of the less complex RT clusters, and that both clusters imply the presence of simplex Onsets. The other scale relates to the licensers (\(\alpha\ \subset\ \varepsilon\ \subset\ \emptyset\)): it says that if a structure is licensed by an empty Nucleus it may also be licensed by schwa and a full vowel.

Polish has only two types of licensers, that is, full vowels and empty Nuclei. The latter, as we have seen, license with a vengeance. Let us consider how much a child may induce about the syllable structure of its language on the basis of the single input wi\(\text{\'a}t\)r [\(\text{\'a}tr\] ‘wind’, which has a word-final TR cluster, that is, it represents level III of syllabic complexity, licensed by the weakest licenser.

\(^{35}\) For a more detailed discussion of markedness and typology issues connected with this model see (Cyran 2003).
Phonetically speaking, the induced structures form a vast set of configurations which are expected to be grammatical on the basis of this single input form, for example, [...trα, ...rt, ...rτα, ...t, ...tα, ...rα]. In fact, this single input allows the learner to fill in the entire syllabic space in Polish as shown under (18). Note that if the input word was czart [tʃart] < /tʃar/ ‘devil’, the child would be able to induce only the less complex structures and would not discover final TRs by any implication. It is also interesting that each single input strengthens the unmarked status of CV. Thus, the gradation of the formal complexity corresponds also to the relative entrenchment of particular structures in a given system.

To conclude, the required amount of input for a learner of a complicated syllabic system like Polish is really small, which agrees with general intuitions concerning viable models of language acquisition (e.g. Chomsky 1965). Each positive input allows the child to create a vast number of potentially grammatical structures. In this sense, the model of complexity scale and licensing seems to be superior to approaches in which grammar acquisition consists of ranking constraints on what is impossible rather than what is possible. Such models require much more input (e.g. Boersma & Hayes 2001, Tesar & Smolensky 1998). Of course the question remains how the model of complexity scale itself is learned, a dilemma that any theory of acquisition has to face.

6. Conclusions

This paper attempted to extend the domain of interest with respect to the phonological effects of being in a strong or weak prosodic context from single segments to consonant clusters. The need for such an extension stems from the empirical facts which clearly show that, to a great extent, the same contexts have a similar effect on the distribution of segments and
clusters. What is more, the contexts themselves are interrelated, and can be viewed in a uniform fashion if the word-final context (\#) is assumed to be pre-nuclear, that is, the final consonant is an Onset followed by an empty Nucleus. The key to understanding the empirical facts discussed in this paper lies in the interaction between structural complexity, defined formally by the presence or absence of government, and licensing strength of the respective contexts. Generally speaking, complexity costs, while licensing, being stronger or weaker, leads to a particular typology, markedness tendencies and processes.

Some complexity effects are also present at the level of a single segment. It is called substantive complexity and may be expressed by reference to the number of subsegmental primes, for example, elements. This complexity exhibits similar distributional tendencies as the formal one which forms a non-arbitrary scale \( C \subset RT \subset TR \) in which a branching Onset (TR) is the most complex structure and implies the presence of a Coda-Onset contact (RT). Both imply the presence of a simplex Onset (C).

The complexity scales, whether substantive or formal, interact with a non-arbitrary scale of licensors \( \alpha \subset \sigma \subset \emptyset \) in which the empty Nucleus (\( \emptyset \)) is the weakest licenser, while the full vowel (\( \alpha \)) is the strongest. In addition, some languages feature a Nucleus of intermediate licensing strength, schwa. In this paper, the empty Nucleus refers only to the word-final situation and replaces the context \( \# \).

The entire syllabic space, and therefore the word structure in any language, is defined by the interaction between the scales of complexity and licensing strength. Thus government and licensing are the main principles organizing speech sounds into words.

Lenition and Fortition gain a new perspective in this paper. While the lenition of single segments may be defined rather uncontroversially as reduction of substantive structure under weakened licensing (element loss), the effects of weak licensing on consonant clusters include a number of potential outcomes, such as epenthesis, metathesis, distributional gaps, but also lenition of one of the members of the cluster, or even simplification of the cluster by segment deletion. In general, then, weak licensing in the case of consonant clusters also results in loss of structure, although the strategies may appear to be very different from lenition.

Fortition, on the other hand, that is, gaining structure in single segments under strong licensing, needs to be further studied, especially with respect to consonant clusters.
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