THE MOLECULAR STRUCTURE OF PHONOLOGICAL SEGMENTS

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1. *Introduction*

1.1 *Goals*

I wish to suggest a structure for the organisation of phonological primes. This structure reveals hidden properties that are of considerable phonological interest. The proposal in this article is a contribution to the phonological model known as Dependency Phonology (DP); cf. Anderson & Ewen (1987). The set of structures is intended to be complete, and to cover all and only the possible phonological segments.[1] The focus of our attention will be on 'basic structures', i.e. structures that represent non-complex (or simplex) segments. It is of course clear that there is no pretheoretical concept of 'complex segment'; this means that all segment types that are not accounted for in terms of the basic structures are by definition either complex or impossible. I cannot present a full treatment of 'complex segments' here (see van der Hulst, to appear); however, my basic claim is that all complex segment types involve an 'adjunction structure'. In the course of this article, I will introduce the necessary adjunction structures, and in §7 I will offer a brief summary of this aspect of the proposal.

This article does not look in any detail at phonological processes. The 'data' for the current proposal are the phonological distinctions or categories that are 'generally acknowledged'. This means that the focus is on potential phonological contrasts and thus, indirectly, on phonological inventories. Put differently, my data are the systems of distinctive features generally used by phonologists (Jakobson *et al.* 1952; Keating 1987; Clements & Hume 1995; Halle 2003), although it is clear that there is no complete consensus on what the features are. Where controversy exists, the model proposed here, RADICAL CV PHONOLOGY (RCVP) generally chooses a solution that is in the first instance

[1] I should acknowledge that I anticipate the need for a number of constraints to block unwanted structures. I reluctantly accept such constraints, seeing them as signals that the system must be made more restrictive in principled ways that I as yet have not been able to formulate.

dictated by the internal logic of the theory. My goal in designing the RCVP system is to achieve an elegant, internally consistent and restricted model that has maximal empirical coverage. In this article (as elsewhere) I emphasise theoretical rather than empirical arguments in favour of the proposed system. I do this because I am not proposing any new or revolutionary 'features' or 'feature groupings'. Hence whatever supports the features and groupings that RCVP reconstructs also supports my system. My primary goal is to show that reasonable proposals for features and their groupings can be shown to embody a hidden structure brought to light in the dependency structures proposed here.

These proposals are further developments of the ideas that John Anderson (in collaboration with several of his colleagues) has put forward since the early seventies in the domain of segmental and syllabic structures. In some cases it may perhaps be difficult to recognise the continuity that I see, but there is no doubt in my mind that what follows owes an enormous intellectual debt to his original and groundbreaking work. The depth and explanatory potential of Dependency Phonology has not been fully appreciated within the phonological community at large, but this can hardly diminish the satisfaction and excitement that it gives to those who work within this model. The system I propose here is the result of my work on DP since I started to become interested in this model, some fifteen years ago. Earlier versions of (parts of) the RCVP model can be found in van der Hulst (1988a, b, 1989, 1994a, b, 1995, 1996, 1999, to appear, in preparation). I can think of no greater tribute to John Anderson then to make an attempt to tie all my prior 'fiddling with Cs and Vs' together in one presentation. The present article anticipates a more extensive presentation of RCVP in van der Hulst (in preparation).

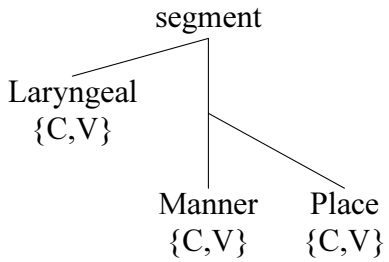
The structure of this article is as follows. In the remainder of §1 I will deal with some fundamental aspects of the model. In §§2–4 I discuss the manner, place and laryngeal gestures. §5 deals with nasality, and §6 with 'incomplete segments'. In §7 I briefly discuss complex segments, and in §8 some parallels between RCVP and recent work in Government Phonology (GP) on phonological elements. The essence of RCVP is summarised in six appendices.

1.2 *Segmental structure: gestures and elements*

In RCVP the phonological segment is made up of three GESTURES. Each gesture contains two ELEMENTS:[2]

[2] The DP term 'gesture' is equivalent to the 'class nodes' introduced in Clements (1985), Sagey (1986) and subsequent work in feature geometry. DP uses the term 'component' for what others call 'single-valued features'. I use the term 'element', as in GP.

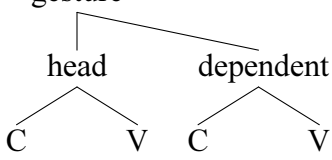
(1)



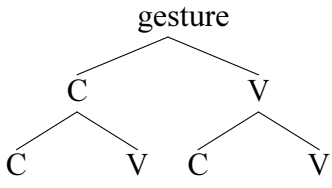
The 'X-bar' geometry in (1) (ignoring the head/dependency relations) has much in common with the feature geometry proposed by Clements (1985), and differs from DP proposals in lacking a nasality gesture; cf. §5. Since C and V are used in all three gestures (an instance of what John Anderson calls the 'Structural Analogy Assumption'), RCVP reduces the total number of elements to two. I take the manner gesture to be the head because it is, as we will see, obligatory for all syllabic positions, whereas the place and laryngeal gestures are only relevant to heads of syllabic constituents, making them dependents. I take laryngeal to be the 'outer' dependent (the 'specifier'), because it is the more optional gesture. An additional piece of evidence for its outer status may be the greater mobility of laryngeal properties in terms of suprasegmental 'spreading', particularly in tonal systems.

Each gesture allows a PRIMARY DISTINCTION between C and V (the head distinction) and a SECONDARY DISTINCTION (the dependent distinction). (2a) and (2b) are two notations to express this. I will henceforth refer to the PRIMARY SUBGESTURE and SECONDARY SUBGESTURE within each gesture:

(2) a.



b.



(primary distinction: head)

(secondary distinction: dependent)

The structure in (2b) was used in earlier articles on RCVP; here I employ the notation in (2a). Many alternative notations could be and have been used (both in previous versions of RCVP and in other works that invoke the head/dependency relation), for example:

(3) a. C C V V b. C Cv Vc V

c. C C_v V_c V d. C C.V V.C V

(3a) is the familiar notation introduced in DP (Anderson & Ewen 1987). In this article, I will use (3b) as a convenient 'flat' notation.

Irrespective of the notation that we choose, an issue that must be settled is whether we will need two *additional* structures involving a dependent that is identical to the head. This would allow the two structures in bold in (4), in addition to the four structures we already have in (3):

(4) C **Cc** Cv Vc V **Vv**

If this six-way distinction is *not* needed (this is an empirical issue), we must invoke a constraint that either directly forbids the option of having the same element twice (as in (5a)) or stipulates the equivalence in (5b):

(5) a. *Xx b. X = Xx

If (5) is adopted, the presence or absence of a dependent element that is identical to the head element is not a distinctive option. Effectively, this means that we could regard X as an 'underspecified' form of Xx. I will assume the more restrictive option that only four basic structures per gesture are needed.[3] I will assume that X is an underspecified form of Xx, and therefore adopt the formulation of the constraint in (5b). The reason for this is that RCVP assigns different (though related) phonetic interpretations to elements in their head and dependent roles (as originally suggested in van der Hulst 1988a, b; the idea is implicit in earlier DP proposals). This being so, it will turn out that dependents that are identical to their heads, despite being predictable and thus redundant, function as 'enhancers' that guarantee a maximal (perceptual) contrast between the relevant phonological categories. We can relate this to 'markedness' as follows: a dependent 'copy' is the unmarked dependent. Henceforth I will use the notation X(x) (with parentheses indicating predictability) for the two unmarked cases in which the dependent and the head are the same element, i.e. C(c), V(v). I return to this in §2.1.3.

In addition to the four structures that are now permitted for each gesture, other conceivable structures might be considered. Indeed, Anderson & Ewen, who use the elements C and V only in their equivalent of my manner gesture,

[3] However, I will recognise the need for additional structures that involve 'adjunction'.

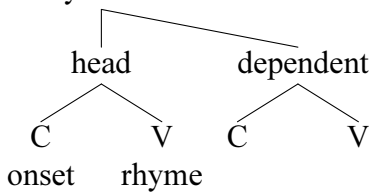
'experiment' with additional combinations. Their proposals include admitting the relationship of 'mutual dependency' (notated as C:V) as a fifth basic structure alongside those in (3a), as well as various complex structures that consist of combinations of the five basic structures.[4] In van der Hulst (1995) I discuss this set of structures, showing that in their proposal additional structures are possible for which no apparent use is suggested. Thus, I conclude that DP is in need of a more concise definition of what is a possible C/V structure. My own work in this area (starting with van der Hulst 1988a, b and den Dikken & van der Hulst 1988) arose from the desire to formulate precisely the 'syntax' of CV combinations and of combinations of elements in other gestures, e.g. the A, I and U elements in the place gesture. I subsequently adopted the idea of using the same elements in all gestures, while at the same time reducing their number to two. The labels chosen for these elements were C and V, and thus the framework has come to be called Radical CV Phonology. Clearly, the labels could have been different, indeed arbitrary. The seeds for the cross-gestural use of the same elements were planted in Anderson & Ewen (1987), who suggest firstly that the place element A can be identified with the manner element V, in that both represent optimal vowel properties, and secondly that I and U might be used as tonal elements ('high' and 'low' respectively), given the intrinsic pitch qualities that can be associated with the place elements. RCVP takes these suggestions to their logical conclusion. In addition, it pursues the idea that the syntax of CV combinations is the same in all gestures. What this means is that in all three gestures we can find a use for the four basic structures in (3). However, this turns out to not be enough, so RCVP also allows a restricted form of adjunction. The idea of using the same primes in different gestures has not been proposed in feature geometry, because this approach uses primes that are closely linked to phonetic realisation. RCVP thus advocates a looser link between phonological primes and phonetic interpretation. As will be shown, this does not imply that phonetics is ignored or deemed unimportant. On the contrary, RCVP is highly specific and explicit about the (many) phonetic interpretations of the elements C and V.

1.3 *Syllable structure and segmental structure*

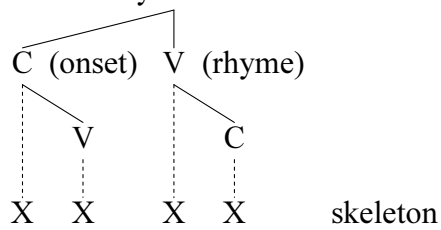
RCVP adopts the view that the syllable has maximally four positions, defined in terms of the same logic that gives us four categories per gesture:

[4] Another conceivable type of structure that needs to be considered is the 'headless' structure used in GP. In a way, this structure embodies the 'fifth option' represented by mutual dependency in DP. In the notation in (3d), used in this model, such headless structures would be represented as (_.C) or (_.V). RCVP does not use such structures, which thus must be excluded by a constraint. Some further remarks about GP will be made in §8.

(6) a.



b.



c. C(c) Cv V(v) Vc

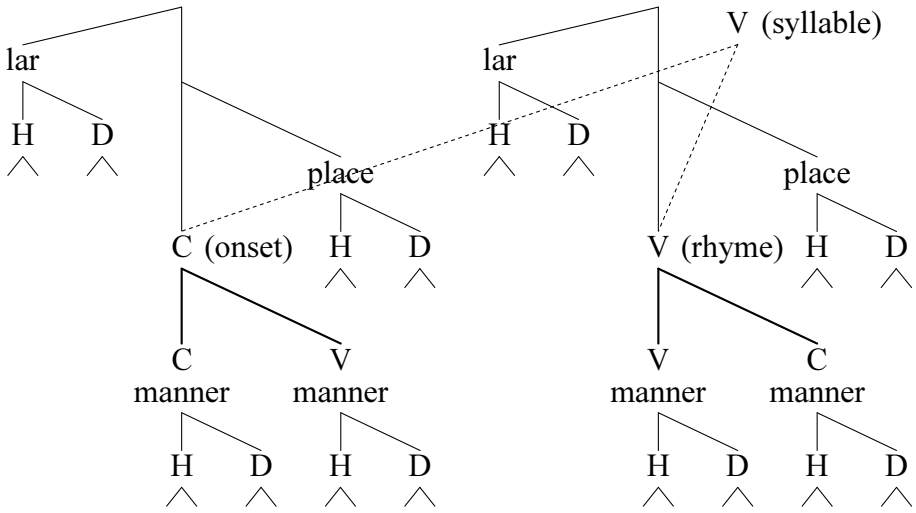
(6a) can be interpreted as follows. The head distinction corresponds to the choice between onset and rhyme, while the addition of a dependent choice represents a dependent position within each of these two syllabic constituents. The dependency graph in (6b) shows the four choices in terms of a traditional syllable structure. We will see later that the C and V labels in (6) have phonetic interpretations that correspond to 'major class features'. The syllable, then, is constituted by the same two elements that also constitute the gestures. (6c) gives the CV labelling of the four syllabic positions. Note that it follows from the notation in (6c) that heads of syllabic constituents are 'unmarked'. Does it also show that onset dependents are more marked than rhyme dependents, as is suggested to be empirically correct in Kaye & Lowenstamm (1985)? It would seem that it does, if we label the syllable itself as a V category. This is reasonable, given that the rhyme arguably forms the head of the syllable.[5] Using this notation, the rhyme, V(v), would be unmarked, and the onset, Vc, marked. By transitivity, the onset dependent would then also be more marked than the rhyme dependent.

[5] The issue of whether the syllable forms a constituent in the phonological hierarchy (as traditionally assumed) or not (as advocated in GP) will not be addressed here.

By labelling the syllable in terms of V, we raise the question of whether there are also 'C syllables', i.e. whether the CV labelling extend to the foot level. I discuss this matter in van der Hulst (in preparation). On the one hand we would like to say that all syllables are of the same type, *viz*. V, while on the other hand we need to encode headedness at the foot level, suggesting that head syllables should be labelled V and dependent syllables C.

Whereas all four syllabic positions require (at least)[6] a four-way manner distinction, it will be shown that place and laryngeal distinctions apply to syllabic heads only, implying that onset and rhyme dependents do not have their own distinctions for these two gestures. Thus we can represent onsets and rhymes as structures that have at most one laryngeal and one place node, while two manner nodes are present in branching syllabic constituents.[7] This allows us to represent the laryngeal and place gesture as properties of syllabic constituents, integrating the syllabic and segmental structure as in (7):

(7)



Each '∧' indicates an intra-subgestural choice between C and V (cf. (2a)). The bold lines represent the syllabic constituents onset and rhyme, which together form the syllable (indicated by the dotted line; cf. note 5). In this representation, the distinctions expressed in terms of syllabic structure (essentially the major class distinctions, as we will see) and (other) manner distinctions, expressed in the manner gesture, are maximally integrated. Since all of these distinctions involve (some degree of) stricture, their structural closeness seems appropriate. In the notation in (7), the manner gesture is dominated by each syllabic terminal, whereas the place and laryngeal gestures are represented as 'supra-onset' and 'supra-rhyme' gestures to indicate that they occur only once per syllabic constituent, being relevant to the heads of these units.

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[6] Additional structures will be needed that require 'adjunction'; cf. §7.

[7] The presence of the laryngeal gesture is optional from a cross-linguistic point of view, at least for vowels. It is only present in tonal languages. I assume that the laryngeal gesture is always present for obstruents, while the place gesture is usually present. In §6, I discuss 'incomplete' structures which lack manner, place or both.

The structure in (7) incorporates several claims that are not unique to RCVP. By interweaving the syllabic structure and the 'content' structure in this way, RCVP claims that the basic syllable is a CV unit, a position shared with Lowenstamm's (1996, 1999) 'Strict CV' GP model. However, it also acknowledges that both the C (onset) and the V (rhyme) units can be (maximally) binary branching; this idea is shared with 'standard' GP. The integration of 'structure' (syllable structure) and 'content' (elements) echoes Hirst's (1985) treatment of complex onsets as 'complex segments'. Kehrein & Golston (2004) argue that laryngeal properties are properties of syllabic constituents rather than of skeletal positions. Finally, Golston & van der Hulst (1999) propose that major class distinctions be expressed in terms of syllable structure, as here.

1.4 *Phonetic interpretation*

It is probably an understatement to say that the two elements (C and V, or however we label them) are rather abstract if taken out of context.[8] However, each specific occurrence of C and V corresponds to a specific PHONETIC INTERPRETATION or EXPONENT, which I will represent here in terms of traditional (articulatorily based) labels.[9] The 'specific occurrence' of an element involves three structural distinctions (all involving head/dependent choices):

(8) *The phonetic interpretation of C and V is determined by*:[10]
- a. *Syllabic position* (four options)
  - onset head
  - onset dependent
  - rhyme head
  - rhyme dependent
- b. *Gesture* (three options)
  - manner (head)
  - place (dependent, complement)
  - laryngeal (dependent, specifier)
- c. *Role* (two options)
  - primary subgesture (head)
  - secondary subgesture (dependent)

[8] RCVP has a family resemblance to glossematic theory (Siertsema 1955; Anderson 1985; Hjelmslev 1985) in regarding the primes of phonology as devoid of phonetic content. It is therefore unlike DP, in which the phonetic basis of primes is taken to be essential. Nevertheless, the seeds for the abstract direction taken by RCVP were planted by John Anderson.

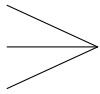
[9] I assume, though, that phonological primitives correspond to both perceptual-acoustic and articulatory events; cf. van der Hulst (in press).

[10] This does not take into account the interpretation of CV structures as adjuncts.

Thus the element C is interpreted as [–continuant] in the following case:

(9) *The interpretation of C*

a. Syllabic position: onset head
b. Gesture: manner
c. Role: primary subgesture



As already mentioned, RCVP claims that within each gesture there is a maximum of four contrastive choices. This is a fundamental claim that is unique to RCVP. However, languages can have somewhat different phonetic implementations of these choices, which is permitted as long as the phonetic choices in question never occur contrastively within a single language.

In addition, RCVP does not, of course, predict that all languages have all potential distinctions within each gesture. If that were true, then all languages would have the same phoneme inventory. Likewise, it is not claimed that onset and rhyme instantiations of gestures are developed in a parallel fashion. For example, it is not necessarily the case that consonants and vowels have the same number of place distinctions. Languages differ in terms of how they have developed the potential set of distinctions within each gesture. What RCVP does predict is that if a language has fewer distinctions in some gesture than those that are theoretically possible, it will first have the unmarked distinctions. Finally, RCVP makes no prediction with respect to uneven development of the different gestures. In principle one language could have a rich manner array and a poor place array, and another language the opposite.

The elements C and V are unary (or monovalent or privative) phonological primes. The use of privative primes only is characteristic of DP and represents the most restrictive position.[11] In the debate between proponents of binary feature systems and unary system, RCVP occupies a unique position: it adopts one binary pair of unary primes.

We now turn our attention to the basic structures and what they 'stand for' in terms of phonetic (articulatory and acoustic) properties.

2. *Manner*

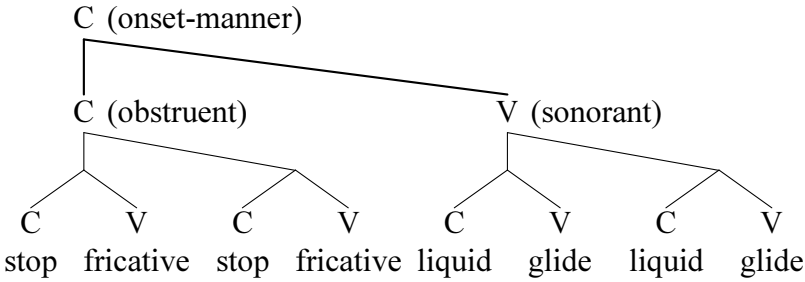
2.1 *Onset structures*

Since the manner gesture is relevant to all four syllabic positions, we have to specify a four-way choice for each of these syllabic positions. In (10) I

[11] Another early source for this proposal is Sanders (1974). Schane (1984a) (and Kaye *et al.* 1985), defends the unary position by adopting the DP 'AIU' elements for place distinctions.

specify the onset distinctions, both in head and dependent positions; rhyme manner will be dealt with in §2.2.

(10)



The two skeletal positions in the onsets are labelled C (the head) and V (the dependent). Note that the syllabic labels C and V at this level correspond to the traditional distinction between obstruent and sonorant, and I will assume that the two positions are reserved for obstruents and sonorants. I will return to this point below, when I discuss the implications of the model for universally permissible phonotactic patterns. In (10) I give the same phonetic interpretations ('stop' and 'fricative', or 'liquid' and 'glide') for primary and secondary occurrences, in order to indicate that the secondary, dependent C and V function as enhancers of the primary head choices. I will provide below more specific phonetic glosses for the dependent occurrences of C and V.

Let us first focus on the four-way manner distinction in onset head position. The primary (i.e. head) distinction is that between stops and fricatives. Since the onset itself is a C-type constituent and stops are the C choice within the primary subgesture, it follows from the notation that stops are unmarked onsets. This is expressed in the following principle:

(11) BIAS
In X constituents X is preferred over Y.

What are we to make of C(c), i.e. a $\text{stop}_{(\text{stop})}$, as opposed to Cv, a $\text{stop}_{(\text{fric})}$, and Vc, a $\text{fric}_{\text{stop}}$, as opposed to V(v), a $\text{fric}_{\text{fric}}$? A $\text{stop}_{(\text{stop})}$ or a $\text{fric}_{(\text{fric})}$ is a 'good' or 'optimal' stop or fricative, because we have assumed that X(x) is unmarked in comparison to Xy (cf. (5)). Let us make this explicit by adopting another, related principle:

(12) ENHANCEMENT
For X heads, X dependents are preferred over Y dependents (and can be left unspecified).

We need to ask which kinds of phonological distinctions are needed within the realm of stops and fricatives. Candidates are 'voicing', 'stridency', 'tenseness', 'lateralisation' and 'nasalisation', all of which have been suggested as 'manner-like', potentially distinctive properties of stops and fricatives. It is of course possible to argue that all these properties are available and thus competing, mutually exclusive exponents of C and V dependents, but this seems unlikely, as there are cases in which some of these phonetic distinctions can create contrast. In English, for example, we find both voicing and stridency in the fricative system. In such a case, it might seem obvious to relegate 'voicing' to the laryngeal gesture, which might be considered a more likely locus.

Anderson & Ewen (1987), however, express 'voicing' in the manner node, making it a unique property of obstruents, expressed by a dependent V. Thus, the structure Cv represents a voiced stop. This adequately accounts for the fact that voiced stops are more marked than voiceless stops (which would be just C for Anderson & Ewen, or C(c) here). If we adopt this idea, we predict that voiced fricatives, V(v), are less marked than voiceless fricatives, Vc. We are committed to this prediction, which I take to be false, because of the principle in (12) which says that 'copy' dependents (which can be left unspecified) are unmarked dependents. To avoid this problem, I explore another option here, that dependent V represents stridency.[12] If stridency is the relevant dimension, strident stops would be affricates, an idea going back to at least Jakobson *et al.* (1952). This proposal translates into the interpretations given in (13) for the four basic manner structures in onset head; I also give the interpretations for onset dependent manners, to which I will turn in a moment:

(13) a. *Onset head manners*

C(c)	stop *stop*	⇒	non-strident: /p/
Cv	stop *fricative*	⇒	strident, i.e. affricate: /pf/
Vc	fricative *stop*	⇒	non-strident: /ɸ/
V(v)	fricative *fricative*	⇒	strident: /f/

b. *Onset dependent manners*

C(c)	liquid *liquid*	⇒	lateral: /l/
Cv	liquid *glide*	⇒	rhotic: /r/
Vc	glide *liquid*	⇒	front: /j/
V(v)	glide *glide*	⇒	back-round: /w/

[12] Anderson & Ewen (1987) represent stridency with the element C in a structure that roughly corresponds to what I will call 'adjunction structures'.

In (13) the double-shafted arrow assigns a specific phonetic interpretation to the italic instance of the labels to the left of the arrow; after the arrow I display an example of a sound that displays the relevant property.

The choice of stridency excludes the other possibilities mentioned above, which must then find an expression elsewhere in the system. Lateralisation will be expressed in terms of adjunction structures, 'tenseness' and voicing will be dealt with as laryngeal properties and nasality is discussed in §5.

Turning our attention to the onset dependent position in (10) and the corresponding four-way opposition in (13b), we observe that the primary division in this position is suggested to be that between liquids and 'glides' or 'approximants', with each allowing a secondary binary split. The primary split within both classes seems appropriate, but it might strike the reader as odd that the secondary split between /j/ and /w/ is represented as a manner distinction in this system, rather than as a place distinction. I claimed above that RCVP is 'trying to get away' with the idea that place properties (as well as laryngeal properties) are distinctive for the onset head position only. This being so, we are 'lucky' that we can derive the /j/–/w/ opposition, which seems necessary in the onset dependent position, as a manner opposition. The 'epiphenomenal' place properties of /j/ and /w/ are not, however, random, given that in the place gesture the properties 'palatal' and 'labial' are expressions of the C and V elements (cf. §3), the dependent elements of /j/ and /w/, respectively.

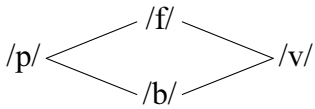
As represented here, /l/ is a 'stronger' form of /j/, and /r/ of /w/. The following substitutions (common in child language, for example) thus reflect a weakening of head C to head V:

(14) a. /l/ → /j/ C(c) → Vc
/r/ → /w/ Cv → V(v)
b. /l/ → /w/ C(c) → V(v)
/r/ → /j/ Cv → Vc

The 'vocalisation' of /l/ to /w/ in (14b) accounts for the difference between English *old* and Dutch *oud*. Here both head and dependent C have weakened to V. Weakening of /r/ to /j/ occurs in Brazilian Portuguese (*branco* → *bjanco*).

In general, of course, we would hope that the structures proposed in RCVP provide an easy and straightforward basis for the expression of phonological processes. I refer to van der Hulst (in preparation) for extensive demonstration that this is often indeed the case. In Anderson & Ewen (1987) common patterns of intervocalic weakening are said to involve the overall change of C-ness to V-ness. In RCVP, the intervocalic weakening routes (in 15a) would be represented as in (15b)

(15) a.



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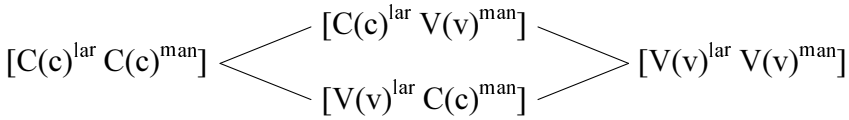


As we will see in §4, Vv in the laryngeal gesture represents voice and Cc voicelessness. Clearly, the triggering environment for this kind of weakening is the surrounding vocalic Vv environment.

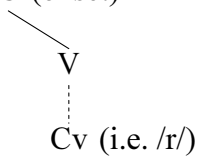
We have now seen that RCVP claims that complex onsets have obstruents as heads and (non-nasal) sonorants as dependents, each allowing a four-way distinction. This means that the sequences in (16a) are possible complex onsets, while those in (16b) are not:

(16)	a. *Possible onsets*	b. *Impossible onsets*
	kr, bl, kj, kw, tr, …	rk, mb, kn, kk, wr, lp, …

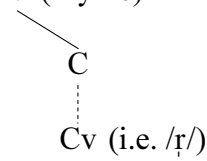
It is well known that languages may have apparent onsets which RCVP characterises as impossible, often only word-initially. To analyse these cases, RCVP adopts the research programme of Head-driven Phonology (based on DP and GP; cf. Kaye *et al.* 1990; Ritter 1995; van der Hulst & Ritter 1999b, in preparation); such alleged complex onsets are sequences of onsets with intervening silent rhymes (see §6.1 for the characterisation of such rhymes).

A second consequence of our proposals for onset structure is that onsets consisting of sonorants only must be represented as 'empty-headed':

(17) a.



b.



In (17b), we see the rhymal equivalent of (17a), which will be used for 'syllabic' sonorants. There is no corresponding special term for sonorants that have no onset head, but from a phonetic point of view it seems clear that whereas syllabic sonorants are weaker, more vocalic forms of this class, 'orphan sonorants' in the onset are more consonantal versions.

Let us now relate the structures in (13) to markedness, a relational concept. When we talk about the markedness of a segment type Z as opposed to W, we

might be talking about the likelihood of occurrence of Z or W in a given syllabic position (syllabic occurrence). However, we might also be talking about the likelihood of Z occurring in a system lacking W (system occurrence), at lexical frequency (lexical occurrence) or appearance in acquisition (developmental occurrence). Other forms of likelihood could be added to this list; cf. Rice (2003) for a thorough overview of the notion of markedness in phonology. It turns out that all forms of likelihood usually converge on the same preference rankings. Thus if Z is more likely to be, say, an onset head, it is also more likely to occur in the absence of W in a phonological system. In addition, it may be acquired earlier and the lexical frequency may be higher.

We already have established that obstruents are less marked as members of onsets than sonorants, given that the latter necessarily occur in a more marked syllabic position (according to (11)), i.e. Cv (onset dependent position). Obstruents in the present system occur in C(c) (onset head) position, the unmarked onset position. Hence obstruents are less marked than sonorants.

I will now discuss whether our CV encoding of the various obstruents and sonorant types correlates with likelihood of syllabic occurrence. As a starting point, let us assume that the rankings per syllabic position are as follows:

(18) a. Onset head p > f > pf > ɸ
b. Onset dependent l > r > w > j

I take it that, given the set in (18a), it is uncontroversial that plain voiceless stops form the least marked onsets, /ɸ/ being the worst choice. This point is of course influenced by the rarity of /ɸ/, itself a result of its marked status. With respect to the two intermediate categories, it seems clear that /f/ is better than /pf/, both because /f/ is much more frequent than /pf/ (typologically and lexically) and because it is much more likely than /pf/ to combine with an onset dependent.

In onset dependent position, I assume that liquids are preferred over glides. This is supported by the fact that branching onsets with liquids are the most frequent in languages that permit branching onsets, and sometimes the only ones allowed. I also assume that within each of these two categories /l/ and /w/ are preferred. At present, I do not have support for the ranking of /l/ over /r/. One piece of support for ranking /w/ over /j/ comes from the fact that in Dutch some branching onsets with /w/ are allowed, while /j/ is not capable of forming a branching onset (van der Hulst 1984; Trommelen 1984). Trommelen, in fact, proposes that /w/ is a liquid for that reason. The facts in English may be similar, if we recognise that alleged complex onsets with /j/ in second position are phonetic variants of simple onsets before the vowel /u/ (as in *tune* [tjun]).

Let us now look at the two scales in (18) in terms of the CV structures that account for the segment types:

(19) a. p > f > pf > ɸ
C(c) > Vv > Cv > Vc

b. l > r > w > j
C(c) > Cv > V(v) > Vc

I will now show that we can derive these scales from the principles formulated earlier, BIAS and ENHANCEMENT. However, as formulated, BIAS is ambiguous. Is the preferred X a head, or is it any element, head or dependent? The two versions of BIAS in (20) make different predictions.

(20) a. BIAS(head): in X constituents X-head is preferred over Y-head
C(c), Cv > Vc, V(v) (/p/, /pf/ > /ɸ/, /f/; /l/, /r/ > /j/, /w/)

b. BIAS: in X constituents X is preferred over Y
C(c) > Cv > Vc > V(v) (/p/ > /pf/ > /ɸ/ > /f/; /l/ > /r/ > /j/ > /w/)

(20b) says that an element X in constituent X is preferred, no matter whether the element X is a head or a dependent. This in itself accounts for the complete ranking of the four sonorants, given that we assume (a) that two instances of X are better than one instance of X (X(x) > Xy), and (b) that X as head is better than X as dependent (X > x). In DP we find the notion of 'preponderance of X', which essentially comprises (20b), with these two implicit points. The ranking that (20b) predicts is *not* the one we postulated in (18b). To derive the order in (18b), we need BIAS(head), which imposes only a partial ranking on each set of four consonants. To get the complete ranking we need another principle. I suggest that the relevant other principle is ENHANCEMENT, formulated in (12) above. Together BIAS(head) and ENHANCEMENT derive the ordering in (18b), if BIAS dominates ENHANCEMENT:

(21) *Onset dependent*
a. BIAS(head) C(c)/Cv > V(v)/Vc
b. ENHANCEMENT C(c) > Cv; V(v) > Vc
C(c) > Cv > V(v) > Vc (l > r > w > j = (18b))

To derive the order in (18a), we can use the same two principles, with a different domination:

(22) *Onset head*

a. ENHANCEMENT C(c)/V(v) > Cv/Vc

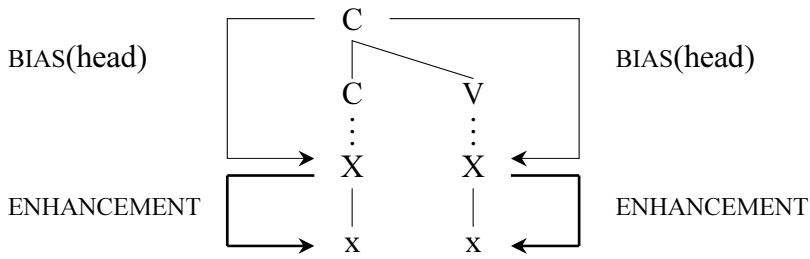
b. BIAS(head) C(c) > V(v); Cv > Vc

C(c) > V(v) > Cv > Vc (p > f > pf > ϕ = (18a))

In onset head position, ENHANCEMENT dominates BIAS(head), while in onset dependent position BIAS(head) dominates ENHANCEMENT. I suggest that the reason for ENHANCEMENT dominating BIAS(head) in head position is that the syllabic head positions favour maximal (perceptual) contrast. I assume that the rankings (both of segments types and constraints) are universal, and therefore reject Optimality Theory-style parochial ranking of constraints.

I mentioned earlier that ENHANCEMENT and BIAS(head) are related principles. Both principles say that within an 'X domain' the occurrence of X is preferred over the occurrence of Y. I illustrate this similarity in (23). The arrows are to be read as stating that the unit at the end of the arrow is preferably identical with the unit that starts the arrow. The thinner arrows represent BIAS(head) and the thicker arrows ENHANCEMENT.

(23)



The motivation or 'grounding' for BIAS(head) is essentially syntagmatic, i.e. the pressure for C-ness is motivated by the contrast with the upcoming V constituent (i.e. the rhyme; cf. Murray & Vennemann 1987). The motivation for ENHANCEMENT, on the other hand, is essentially paradigmatic, involving pressure for maximal (perceptual) contrast in a given position. We arrive at the natural conclusion that paradigmatic pressure is greater in the onset head position than in the onset dependent position, the former being an obviously more salient position. Below, we will see that these findings extend to the rhyme constituent.

One could consider the addition of explicit markedness labels to the RCVP notation. The introduction of such labels in a hierarchical structure would bring out the resemblance between RCVP and earlier approaches found in Shapiro (1972), Kean (1975), Kiparsky (1979; who used SW labels) and Lekach (1979).

However, the advantage of adopting M/U labels (for marked and unmarked) is not obvious. In onsets, one would think, C is unmarked, while V is marked, i.e. C = U, V = M. Adding markedness tables to (13), we arrive at (24):

(24) a. *Onset head manners*

U-U	C(c)	stop *stop*
U-M	Cv	stop *fricative*
M-U	Vc	fricative *stop*
M-M	V(v)	fricative *fricative*

b. *Onset dependent manners*

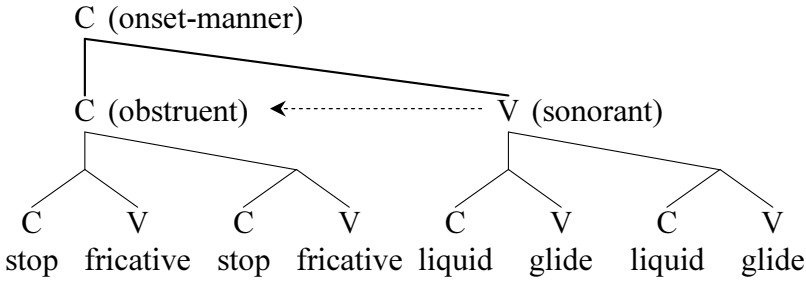
C(c)	liquid *liquid*
Cv	liquid *glide*
Vc	glide *liquid*
V(v)	glide *glide*

It is now clear that the markedness labels simply encode what I have called BIAS. But, as we have seen, BIAS is not the only factor, ENHANCEMENT being relevant as well. I conclude that the use of explicit markedness labels adds nothing to the notation.

The proposal in (10) and (13) leaves 'taps' and 'flaps' unaccounted for. Assuming that these segments are approximants, and noting that a phonemic distinction between taps and flaps has not been found (as argued in Ladefoged & Maddieson 1996:230–231), I will propose in §7 that taps/flaps are 'manner-less' approximants. As far as I know, these segment types do not occur in syllabic dependent positions. Nasals, another so far unmentioned category, will be discussed in §5.

In addition, we have not accounted for 'lateralised obstruents'. These, I suggest, fall under the rubric of complex consonants. Their representation calls for a kind of structure that involves 'adjunction' of the onset dependent manner to the onset head manner.

(25)



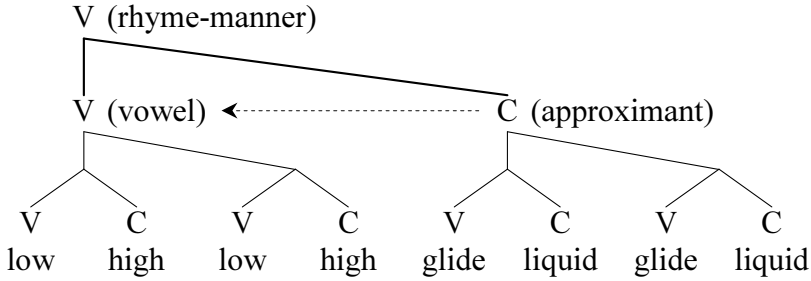
In the formation of adjunction structures, it seems natural that both the host and the adjunct will be unmarked structures. The unmarked adjunct would be C(c) (a lateral), while the least marked host would be either C(c) (a simple stop) or V(v) (a strident fricative). In fact, since lateralised consonants tend to be coronals, we can say that hosts are unmarked in terms of manner and place; in §3 I argue that coronal is the unmarked place. The next best adjunct would

presumably be V(v). V(v) would produce a labialised secondary articulation. We will see later that labialisation can also be derived in another way, so that we can perhaps assume that in this case only the unmarked C(c) can occur as an adjunct. It should be noted that adjunction represents a level of complexity in between branching syllabic constituents and the so-called basic structures.

2.2 *Rhyme manner*

I now turn to the rhyme:

(26)



In the rhyme head, manner encodes vowel height (or closure, or aperture), while the dependent position gives us a set of sonorant consonants (as in the case of the onset dependent position). Observe that this implies that, in general, manner distinctions involve aperture (or stricture).

(27)	a. *Rhyme head*	b. *Rhyme dependent*
V(v)	low *low*: /a/	glide *glide*: /w/
Vc	low *high*: /ɛ ɔ/	glide *liquid*: /j/
Cv	high *low*: /e o/	liquid *glide*: /r/
C(c)	high *high*: /i u/	liquid *liquid*: /l/

I assume that in head position, the markedness ranking in (28) is appropriate, at least as far as the first two categories of vowels are concerned:

(28) a > i u > ɛ ɔ > e o
V(v) C(c) Vc Cv

This means that in rhymal head position, the perceptually driven force of ENHANCEMENT definitely outranks BIAS(head), as expected, given our tentative results for the onset head position. One might take issue with the ranking of low-mid vowels over high-mid vowels in (28). It has been argued that in a five-vowel system we more often find /e o/ than /ɛ ɔ/ (cf. Kaye *et al.* 1985), although there are certainly systems in which this is not so (for example, five-

vowel systems in Bantu languages). Does this mean that there is a hidden pressure that promotes Cv over the more open and thus presumably more sonorant Vc in certain types of languages? Or is it rather that a three-height system (V(v), C(c), Vc) can vary as to the phonetic interpretation of Vc? It might be argued that Vc, in the absence of Cv, is merely a combination of V and C, without a distinctive dependency relation.[13] For the moment, I will adopt this option, and assume that languages can differ in the precise details of spelling out the phonetics of combinations of V and C in cases where the dependency relations between the two elements is not contrastive, giving rise to e/o-like vowels in one language, and to more ɛ/ɔ-like vowels in another.[14]

It seems that our proposal has no place for tense/lax or ATR/RTR distinctions. Firstly, let us note that these two opposition types appear to be in complementary distribution. Some languages appear to be of the tense/lax type (e.g. a number of West Germanic languages), while other languages (notably African languages) have an ATR/RTR opposition. For the mid vowels (where the distinction, whatever form it takes, appears to be the most stable), we already have a potential two-way contrast between Vc and Cv. We must therefore ask how we can represent an extra distinction for high and low vowels. At this point, we must appeal to a form of adjunction that corresponds formally to the adjunction postulated for lateralisation (and perhaps labialisation) of obstruents in onsets, as anticipated in (26). We again expect that only relatively unmarked vowels are subject to adjunction (hence high C(c) and low V(v) vowels). The unmarked adjunct would be V(v) (since we are in the rhyme). I suggest that this structure is interpreted as RTR (or perhaps laxness) when occurring as an adjunct. C(c), the next best adjunct, would then be ATR (or perhaps tenseness):

(29)	*Simplex structure*		*Adjunct*	
	V(v)	low *low*	C(c) (ATR: ə)	V(v) (RTR: ɑ)
	C(c)	high *high*	C(c) (ATR: i u)	V(v) (RTR: ɪ ʊ)

In (29) the tongue-root distinction for high and low vowels is expressed in terms of adjunction to the basic structure. For mid vowels it is expressed by a dependent *within the basic structure* (i.e. Vc for RTR /ɛ ɔ/ and Cv for ATR

[13] This is not the same as admitting a *distinctive* option of 'mutual dependency'; cf. §1.2.

[14] Another possibility is that, for some yet unknown reason, BIAS plays no role in rhymal head position. However, this would not only make the choice between the two mid series random, but would also leave low and high vowels unranked. The choice of the optimal vowel may depend on the status of the rhyme within the foot. A strong rhyme will prefer /a/, while a weak rhyme may prefer /i u/.

/e o/). In both cases RTR involves the presence of a head V element, while ATR involves a head C element. In the mid vowels, these elements are part of the basic structure, whereas they occur in adjunct in the high and low vowels. This nicely accounts for the fact the distinction is more stable for mid vowels.

We need to stipulate that no vowel system has both types at the same time, such that plain vowels contrast with both ATR and RTR counterparts, creating a three-way distinction. Languages apparently express the contrast either with the ATR adjunct C(c) or with the RTR adjunct V(v).[15]

I will assume that the tense/lax distinction is simply a different phonetic exponent of the same two adjuncts. Alternatively, we could say that languages choosing the C(c) adjunct are ATR languages, while those choosing the Vc adjunct are tense/lax languages.[16]

Let us now turn to rhymal dependents. For rhyme dependent positions, I assume that glides are better than liquids; see (30a). This conforms to the claim in Clements (1990) that the 'sonority profile' of the syllable falls gradually rather than steeply. Thus, more sonorant codas are better than less sonorant codas. However, I need to find support for the specifics of the further rankings. Is /w/ better than /j/, and /l/ better than /r/? These orderings are predicted if the coda ordering, like the onset dependent ordering, results from the ranking BIAS(head) ≫ ENHANCEMENT.

(30) a. *Rhyme dependent* (BIAS(head) ≫ ENHANCEMENT)
w > j > l > r
V(v) > Vc > C(c) > Cv

b. *Onset dependent* (BIAS(head) ≫ ENHANCEMENT)
l > r > w > j
C(c) > Cv > V(v) > Vc

The widespread phenomenon of *r*-loss in varieties of English provides support for treating /r/ as the least favoured coda.

In conclusion, then, markedness in rhyme head position is determined first by ENHANCEMENT (the paradigmatic force of 'maximal perceptual contrast'), with BIAS(head) playing a secondary role, (31a). In dependent position we most likely find the opposite ranking:

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[15] We will see that in the case of place or laryngeal adjunction such complementarity is not required. In the case of onset-internal manner adjunction we tentatively suggested that only one adjunction type (lateralisation) is needed.

[16] By representing ATR/RTR and tense/lax in terms of adjunction from the 'coda' we establish a connection between the presence of these properties as syllable closure. In Dutch, for example, lax vowels can only occur in closed syllables. Apparently, the V(v) adjunct creates the need for a consonant 'licensor'. This promising correlation needs to be explored further.

(31) a. *Rhyme head*
ENHANCEMENT ≫ BIAS(head) (a > i u > ɛ ɔ > e o)

b. *Rhyme dependent*
BIAS(head) ≫ ENHANCEMENT ≫ BIAS (w > j > l > r)

These findings are strikingly parallel to those for onsets.

Since only liquids and glides are allowed in dependent position, RCVP embodies the claim that so-called codas (i.e. rhyme dependents) are very restricted. In particular, it follows from the notation that obstruents are not allowed as codas. This relates to the idea within Government Phonology that codas must be licensed by a following onset that *can* license it. Licensing is well formed only if the licenser is less sonorous than the licensee, which in practice boils down to the licensee having to be a sonorant.[17] RCVP derives the fact that only sonorants can be codas, although it is neutral on the question as to whether codas *must* be licensed by a following onset. As in GP, apparent obstruent codas must be onsets that are followed by a silent rhyme.[18]

Three further general points should be mentioned. Firstly, the elements C and V express manner contrasts for both vowel and consonants. Thus, RCVP offers a 'unified' theory of manner. In other work, such as Clements (1993), unification has been set as a goal for place features only, while Halle & Stevens (1971) suggest unification of laryngeal features. RCVP extends these ideas and takes them to their logical extreme: all distinctions are parallel. In §§3 and 4 we will see that parallelism also holds for place and laryngeal distinctions.

Observe secondly that the distinctions between obstruent, vowel and sonorant consonant (liquid, glide) are determined by syllabic positions. Onset heads can only contain obstruents, rhymal heads only vowels and dependent syllabic positions only sonorant consonants. This of course implies that syllabic structure, in this model, is necessarily part of the lexical-phonological structure.

Thirdly, with reference to GP and DP, the following important difference must be highlighted. In RCVP the A element is the 'V choice' in the rhyme *manner* gesture. Thus, A differs from I and U, whose RCVP counterpart will be found in the place gesture. A somewhat similar suggestion has been made in DP (in the suggestion that the 'manner' component |V| could replace the place component |A|). In addition, we note that A in RCVP has a polar counterpart, the 'C choice', interpreted as [high]. This makes RCVP 'non-triangular'.

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[17] GP does allow obstruent combinations (such as /kt/) to be coda–onset sequences, on the assumption that /t/ can govern /k/ because it is more complex; cf. Harris (1990).

[18] This raises questions about the representations of long vowels and geminates in those languages that allow geminates of all types, while excluding non-geminate complex interludes. See van der Hulst (in preparation) for discussion.

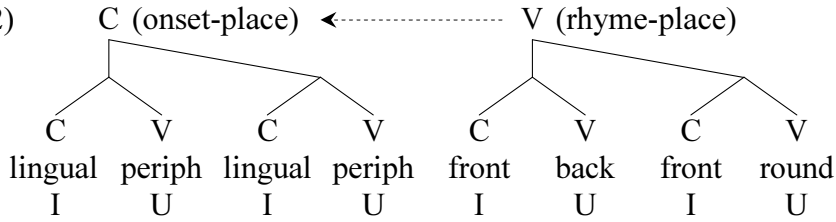
3. *Place*

In this section I discuss the place properties of onset and rhymes jointly. Recall the claim that only syllable heads have place properties, which boils down to saying that only obstruents (onset heads) and vowels (rhyme heads) have (distinctive) place properties, while all sonorant consonants (onset and rhyme dependents) are considered to be phonologically placeless.

3.1 *Basic structures*

I propose that the 'place space' is structured as in (32). I will then show that this proposal presents difficulties that can only be 'solved' by an *ad hoc* constraint whose motivation is unclear to me.[19]

(32)



The examples in (33) illustrate only stops and high vowels. 'T' stands for 'a second coronal consonant', i.e. some sort of 'posterior' coronal.

(33)

onset				*rhyme*	
C(c)	lingual *lingual*	⇒	coronal: /t/	C(c)	front *front*: /i/
Cv	lingual *peripheral*	⇒	coronal: /T/	Cv	front *round*: /y/
Vc	peripheral *lingual*	⇒	dorsal: /k/	Vc	back *front*: /ɯ/
V(v)	peripheral *peripheral*	⇒	labial: /p/	V(v)	back *round*: /u/

Bear in mind that the phoneme mentioned in (33) are examples of the place type. Other consonants, for example, are lingual *lingual* (/d s z/, etc.).

If ENHANCEMENT outranks BIAS we have the following rankings:

(34) *Markedness ordering*

/t/	>	/p/	>	/T/	>	/k/	/u/	>	/i/	>	/ɯ/	>	/y/
C(c)		V(v)		Cv		Vc	V(v)		C(c)		Vc		Cv

[19] Back and round are united from an acoustic point of view: both correspond to lowering of the second formant. Stevens & Keyser (1989) and Stevens *et al.* (1986) refer to roundness as an enhancing feature for backness. Their notion of enhancement corresponds closely to the notion of enhancement used here.

Let us discuss the apparently problematic underlined orderings in (34).

/T/ > /k/. On the consonantal side, the ranking of /T/ (the 'second coronal') over /k/ (velars) is troublesome, given that systems are unlikely to have the former without the latter, whereas the reverse can easily be attested. We could apply the reasoning that we considered in the case of vowel height, where we noticed a similar, although less compelling, problem. Thus, we could also say that C (lingual) + V (peripheral), without a contrastive dependency relation, denotes /k/, while maintaining the interpretations in (34). This would mean that even though /k/ appears before /T/ (perhaps for reasons of maximal perceptual contrast), /T/ is less marked once the opposition between /T/ and /k/ arises.

/ɯ/ > /y/. If this ordering is problematic, we could apply the same reasoning as above for /k/ and /T/. Thus, we could say that even though /y/ can exist without /ɯ/, the latter is less marked once the contrast exists. Of course, this would then imply that loss of the contrast again means that the 'marked' /y/ wins, but this prediction seems contradicted by languages such as Finnish and Hungarian, which have lost /ɯ/ while retaining /y/.

In GP (at least in the theory of Kaye *et al.* 1985) and in some versions of DP, only one combination of I and U is used. In other words, it is assumed that these two elements do not enter into a distinctive dependency relation. If we applied this measure here by adopting a constraint *Vc, this would eliminate a class of segments, namely /k/ and /ɯ/, which would then have to be accommodated differently. In current versions of GP, velar consonants and high central vowels are said to result from 'empty' structures, while earlier variants, as well as DP, have a special type of element, the 'cold vowel' in GP and the 'centrality element' in DP. In §6, I will argue that the strategy considered here cannot be followed within RCVP. Hence I will maintain that the representations in (33) are all valid and interpreted as indicated. The apparent markedness reversal among Vc and Cv will thus remain as a problem that cannot be solved at the moment.

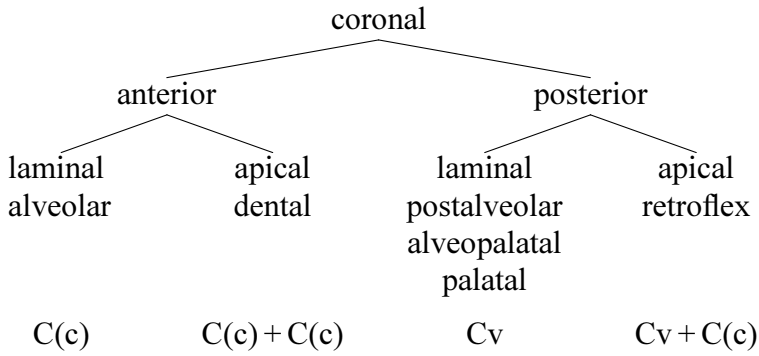
There is one further objection that might be raised against the markedness ordering in (34). On the vocalic side, one might object to ranking /u/ above /i/, given that /i/ has been regarded as 'less marked' because of its favoured role as an epenthetic vowel. One might argue that being favoured as epenthetic does not necessarily make a vowel 'good', but rather 'cheap', and favoured as epenthetic precisely because it is not the best (high) vowel. This point relates to the status of the rhyme in the foot structure. An epenthetic site is likely to be a weak rhyme. Thus /i/ may be preferred in weak rhymes (C-type), whereas /u/ may be preferred in strong rhymes (V-type). Still, /i/ is the most frequent vowel in most languages, and all languages seem to have it.

3.2 *Adjunction*

Further distinctions are needed for consonants, especially in the coronal area. I propose to appeal to adjunction to account for the 'secondary place articulations' C(c)/palatalisation (unmarked) and V(v)/labialisation (marked). Labialisation, in this proposal, is a natural counterpart of palatalisation. We noted in §2.1.5 that labialisation could also be expressed in terms of onset-internal adjunction. Given that we now derive labialisation again, it might be that some other interpretation in either of the two cases could be considered. One candidate would be pharyngealisation (or dorsalisation). However, in §7, I will suggest another instance of adjunction that might receive this interpretation. At this point, I will not force a decision. My feeling is that palatalisation and labialisation are natural candidates for the adjunction options within the place gesture.

When applied to lingual consonants (C(C) = /t/ and Cv = /T/), the C(c) adjunct must be held responsible for a range of different phonetic effects, some of which would not usually be seen as involving a 'secondary' articulation. Apart from causing a /j/-like offglide (i.e. palatalisation), the effects would include that the relevant lingual is more dental or (sub)apical or 'retroflex'. As an example, consider the fact that the 'coronal' area in a number of Australian and Dravidian languages is divided over *four* distinctive categories:

(35)



Adjunction of C(c) here produces two additional, *apical* coronal places.

3.3 *Only syllabic heads have places*

What about the place properties of sonorant consonants (i.e. segments in syllabic dependent positions)? In §1.3 I claimed that place properties apply to syllabic head positions only. Onset and rhyme dependents (liquids) indeed do not require place distinctions. This makes contrastive place distinctions among laterals (e.g. between plain and palatal laterals) potentially problematic. Such

distinctions appear to arise only if laterals occur without onsets heads, however. We can say that in that case place properties that are assigned to onset constituents are realised on the orphan onset sonorants. If a head segment (an obstruent) is present, the place properties are interpreted on this segment. However, if no head segment is present, the place properties can go to the dependent sonorant.

As for glides, a 'place' distinction between /j/ and /w/ seems possible, even in dependent position. However, the reader might recall that this 'place' distinction was analysed as a manner distinction in §2.1.1. Place properties of nasal consonants will be treated along similar lines in §5.

3.4 *Comparison with Clements* (*1993*)

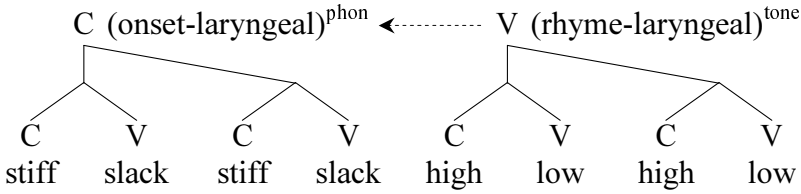
The proposal for place has much in common with the model advanced in Clements (1993), which contains separate C-place and V-place nodes. Indeed, the idea of having a single set of place primes for both consonants and vowels goes back to Sagey (1986) (if not to Jakobson *et al.* 1952), and (as far as my own background is concerned) to DP work dating from the seventies and early eighties (cf. Anderson & Jones 1974, 1977; Ewen 1980). The proposal made here captures the spirit of all these theories. However, to avoid confusion, let me stress that the RCVP CV structures should not be compared directly to the C-place and V-place nodes proposed in Clements (1993). Our segmental 'geometry' has only one place node, just as it has only one laryngeal and one manner node. The phonetic interpretation of the elements in these nodes is dependent on whether the segment is in the onset or rhyme (and, for manner, in head or dependent position).

4. *Laryngeal*

4.1 *Onset structures*

The distinctions discussed in this section, dealing with the most difficult dimension of segmental structure, are traditionally grouped under tone and phonation. I will employ the idea (first put forward in Halle & Stevens 1971) of having one unified set of 'features' to characterise both tone and phonation distinctions (see Bao 1990; Duanmu 1990). Within RCVP this idea is taken a step further. Tone features and phonation properties are taken to be fully complementary, in that the former characterise rhymal (head) segments and the latter characterise onset (head) segments. I propose that the structure in (36) captures the phonological distinctions needed cross-linguistically. Note that I am using the elements C and V in this class too, instead of introducing two new polar elements. This is again the most economical solution.

(36)



(37) a.
C(c)	stiff *stiff*	⇒	voiceless
Cv	stiff *slack*	⇒	breathy (murmur)
Vc	slack *stiff*	⇒	creaky (laryngealised)
V(v)	slack *slack*	⇒	voiced

b.
C(c)	high *high* ([+upper, +raised])
Cv	high *low* ([+upper, –raised])
Vc	low *high* ([–upper, +raised])
V(v)	low *low* ([–upper, –raised])

In accordance with proposals advanced in Golston & van der Hulst (1999) and Kehrein & Golston (2004), RCVP restricts the occurrence of laryngeal contrast to head positions in onsets and rhymes. This is tantamount to saying that laryngeal gestures, like place gestures, are properties of onset and rhyme nodes, rather than properties of skeletal positions.

As for markedness, if ENHANCEMENT dominates (as we now expect for syllabic heads), we predict the following scale for the basic phonation categories:

(38) *Onset*

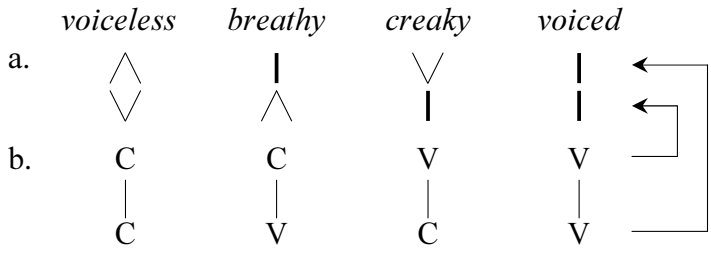
/p/ > /b/ > /bʰ/ > /b̰/

C(c) V(v) Cv Vc

ENHANCEMENT ≫ BIAS(head)

The phonetic glosses ‘stiff’ and ‘slack’ may not be appropriate for the head occurrences of C and V. Consider a schematic representation of the four phonation types; cf. Ladefoged (1993:140):

(39)



In (39b) I use the standard DP representation of the dependency structures to show that the head choices refer to the position of the arytenoid cartilages. C implies that the arytenoids are positioned such that the lower part of the vocal folds are separated, while V implies that they are brought together.[20] Thus we can replace (37a) by (40):

(40) C(c) arytenoids open *vocal cords stiff* ⇒ voiceless
Cv arytenoids open *vocal cords slack* ⇒ breathy (murmur)
Vc arytenoids closed *vocal cords stiff* ⇒ creaky (laryngealised)
V(v) arytenoids closed *vocal cords slack* ⇒ voiced

Ladefoged & Maddieson (1996:ch.3) refer to an additional option: 'modal voice'. They also identify two other categories 'slack voice' (similar to breathy voice) and 'stiff voice' (similar to creaky voice), but do not find contrasts between slack and breathy or between stiff and creaky. Stiff and slack voice may then be two alternative phonetic realisations of the two intermediate phonation types, whereas modal voice may result from the absence of any laryngeal specification; recall that the laryngeal (specifier) gesture is optional.

4.2 *Adjunction*

We need to accommodate a further set of distinctions for consonants, including aspiration and three (or four) exceptional phonation types (implosives – perhaps both voiced and voiceless[21] – ejectives and clicks). At first sight, one might be inclined to add a new gesture. Irrespective of whether we can come up with a reasonable candidate, it would be a problem that this extra gesture would be strictly consonantal, whereas up to now we have developed fully parallel sets of representations for consonants and vowels. In addition, it is not clear where this extra gesture would fit in the X-bar structure for the segment. As an alternative, we might explore whether the distinctions can be accounted for in terms of adjunction, as indicated by the horizontal arrow in (36). Since adjunction is needed anyway, I prefer this approach over the *ad hoc* addition of a consonant-only extra gesture.

What kind of interpretation can we give to adjunction of V(v) and C(c)? We could take V(v), low register (and low tone) to include the phonetic

[20] We see here that C and V do not always correspond to notions such as 'closed' and 'open'. If that were the case, we would expect the opposite correlation. Thus C means 'what is more preferred in onset heads', and V means the opposite.

[21] Ladefoged & Maddieson (1996:60) claim that Owerri Igbo has a voicing contrast for implosives. We might regard the voiceless sounds as a possible manifestation of the glottalised/ejective category. Their table (1996:101) suggests, however, that Igbo (presumably another dialect) has a three-way contrast between voiced implosives, voiceless implosives and ejectives.

property of expanded pharynx, which, among others, is achieved by laryngeal lowering, while C(c) would be the opposite (cf. Trigo 1991). Thus we might suggest that the following interpretations can be derived. As usual, I assume that only unmarked hosts (i.e. C(c) and V(v)) can take adjuncts: [22]

(41)

Basic structure		*Adjunct*			
C(c)	voiceless	V(v)	aspirated	C(c)	ejective
Cv	breathy				
Vc	creaky				
V(v)	voiced	V(v)	breathy voice?	C(c)	implosive

Here we take the adjunct C(c) to represent glottal closure, while the raising or lowering of the larynx is seen as an epiphenomenon, perhaps connected to the voicing contrast of the host. We then take V(v) as indicating aspiration, which suggests a new option for breathiness, which we already accommodated in the basic structures as Cv. This in turn might suggest the option of regarding creaky voice and implosion as complementary realisations of the same category, in which case we might propose blocking the two intermediate basic categories Cv and Vc. This would solve a problem present in (41), that aspirated and glottalised (or ejective) consonants are probably more common than creaky and breathy voice. This is unexpected if only the former involve adjunction. I thus conclude with the following proposal:

(42)

Basic structure		*Adjunct*			
C(c)	voiceless	V(v)	aspirated	C(c)	ejective/glottalised
V(v)	voiced	V(v)	breathy voice	C(c)	implosive/creaky

With ENHANCEMENT ranked above BIAS, C(c) (voiceless) is predicted to be less marked than V(v) (voiced).

There is no contradiction in disallowing complexity in the basic laryngeal structures for consonants. In general, it is to be expected that dependent structures allow less complexity than head structures. It is perhaps also 'reasonable' that specifiers allow less complexity than complements.

This proposal excludes the click category, but it not obvious that this type of segment belongs here at all, given that clicks can have different, contrastive phonation types (cf. Ladefoged & Maddieson 1996:278). It is perhaps possible to accommodate clicks as doubly articulated consonants, which could be represented as a sequence of two onsets (with an intervening silent rhyme), an option that I also propose for multiply articulated segments such as /kp/ and /tp/

[22] I assume that glottalised sounds and ejectives are not distinct phonological categories.

(Ladefoged & Maddieson 1996:ch.10); cf. van der Hulst (in preparation) for discussion.

Another issue that needs to be addressed is how phonation types cross-classify with the various manner types of obstruents and sonorants. As it stands, we predict a maximum of six phonation types for consonants (cf. (42)). It seems unlikely that one single language can be found that has all these types, although Owerri Igbo (Ladefoged & Maddieson 1996:60), with a six-way contrast, seems to fit the bill. We also need to address the point that more options seem available for obstruents than for sonorant consonants (when occurring alone in headless onsets). The latter point could be due to the fact that obstruents are less marked, thus allowing a greater number of adjunction options.

4.3 *Rhyme structures*

As expected, the scale for tones favours the maximal contrast between low and high, low being unmarked. The evidence for low mid being less marked than high mid remains to be found:

(43) *Rhyme*

/L/	>	/H/	>	/L-mid/	>	/H-mid/
V(v)		C(c)		Vc		Cv

ENHANCEMENT ≫ BIAS

We could take the head choice to represent a 'register choice'. The proposal to separate tone and register conforms to the idea (widely accepted since Yip 1980; see also Pulleyblank 1986, and in particular Snider 1988, 2000) that tonal features refer to register and tone proper (melody) respectively. Not all authors have made clear exactly what the phonetic difference is between melody and register. In African languages, register apparently indicates a modification of the tonal distinctions, such that two types of H and L arise. The notion has been used differently, however, in the analysis of Asian languages that are said to have a distinction between 'head' (high) register and 'chest' (low) register, where each register comprises a whole array of distinctions involving the larynx and the pharynx (Trigo 1991). In these cases, register does not necessarily imply a tonal distinction. This may support treating register as the head.[23]

[23] I assume that contour tones can be accounted for without additional adjunction structures, but to elaborate this idea would take us too far afield. See van der Hulst (in preparation).

4.4 *Adjunction*

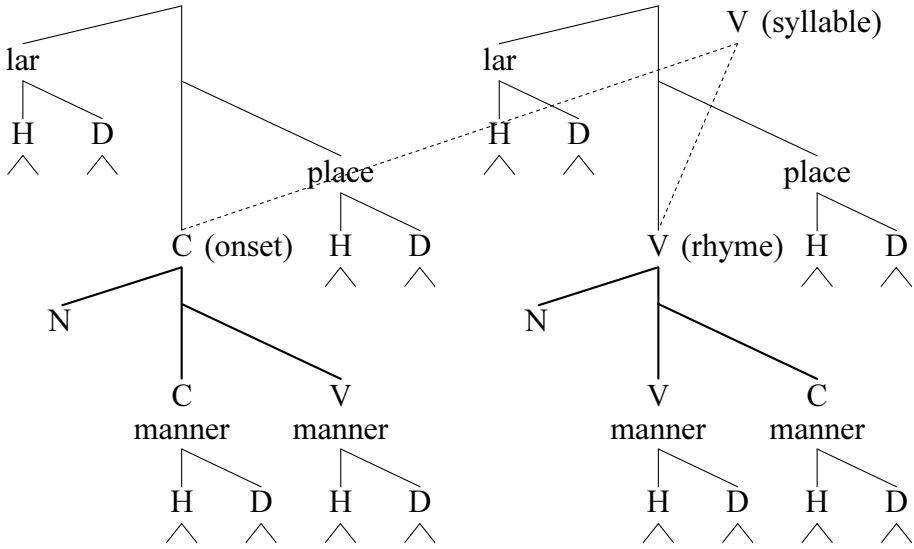
Another area that needs discussion concerns the claimed occurrence of breathy or creaky vowels. If breathiness and creakiness are consonantal phonation type, how can they be realised on vowels? Consider too the phenomenon of depressor consonants, as well as the whole area of tonogenesis. Voicing in our system is V(v), as is low tone. A correlation between these two properties is thus expected. Voicing may indeed give rise to a low tone in tonogenesis and depressor consonants are always voiced. Unfortunately, an exploration of laryngeal consonant–vowel interactions is beyond the scope of this article (see van der Hulst, in preparation).

5. *Nasality*

We now need to find representations for nasal sonorant consonants, prenasalised consonants and nasalised vowels. In all previous versions of RCVP, nasality has proved troublesome. Nasal consonants can have distinctive place; in this sense they behave like onset heads. However, they are sonorants, not obstruents. We also need an account of prenasalised obstruents (stops and fricatives or affricates). In the rhyme part of the syllable, we find nasalised vowels. We seem to need an extra CV split in the segmental structure. But where?

I propose here a strategy which in a sense follows standard DP. Let us say that the nasal gesture contains only one element. To bring out the special status of the nasal gesture, I propose to view this nasal gesture as a 'manner specifier':

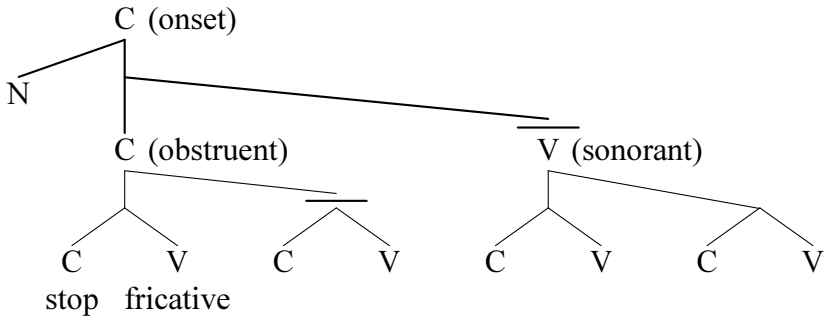
(44)



That the manner gesture now has an extra layer (and indeed forms an X-bar structure by itself) reinforces the proposal that manner is the head gesture of the segment. The question can be raised whether the element N is a C or a V element. We expect that N is a V element in the onset manner gesture, but a C element in the rhyme manner gesture, in both cases being polar in character to the head. This may seem disadvantageous with respect to nasal spreading from consonant to vowel (or *vice versa*), but since there is no contrast within each gesture type, a simple convention can regulate the switch from C to V (or *vice versa*). We might also note that the nasal specifier is simpler in structure (having only one element) than the head and complement part of the manner gesture. Again, this is the kind of complexity asymmetry that we expect to find.

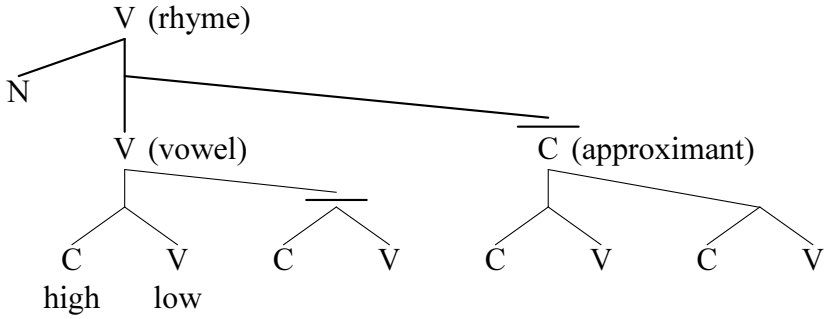
Let us discuss this idea for onset and rhyme structure in more detail, starting with the former. The nasal specifier would be interpreted on the head of the onset if present. It seems appropriate to regard a nasal stop or fricative as a prenasalised obstruent. We need to stipulate that prenasalised obstruents need to be unmarked, and also that they do not take adjuncts or onset dependents.

(45)



Nasal consonants, being sonorants, could be seen as headless onsets (cf. (16a)), so that a nasal consonant is in fact a nasal lateral. This allows nasals to have different places of articulation, because place properties of headless onsets can descend to the complement, as stated earlier.

(46)



In rhyme structures, as in (46), the specifier gives a nasalised vowel. In this case we do not wish to say that only unmarked (high and low) vowels can be nasalised; nasalised mid vowels are common too, albeit perhaps just one mid series.

Nasal vowels are not likely to occur in closed syllables, which suggests that the branching rhyme option is blocked. But one might ask how we represent 'nasal codas' if nasality blocks the option of a branching rhyme. One option is to suggest that nasal codas are simply another way of representing nasal rhymes. Instead of the nasality being realised on the vowel, it is realised as a nasal sonorant. The place of articulation of this 'transitional sound' then *must* come from the following consonant if present, or otherwise follow a default pattern. Final nasals (with an independent (non-default) place) or nasals that are non-homorganic with a following consonant must then be analysed as onsets.

Another possibility that could be explored would allow a coda slot with no content of its own. (We could express this by lowering the horizontal line in (46) below the C.) This might create the appropriate structure for languages that allow nasal coda and codas that are the left half of geminate, but nothing else. See van der Hulst (in preparation) for further discussion of this option.

6. *Incomplete structures*

In this section, I propose an array of degenerate structures, i.e. structures lacking gestural information. I will not be concerned with the absence of the laryngeal gesture, since this is inherently optional (being the 'specifier'). Many languages lack tonal distinctions for vowels. For consonants it is much less common to find complete absence of phonation distinctions, since voicing (which is practically always present) is expressed as a phonation type.[24] The same could be said of the nasal specifier within the manner gesture.

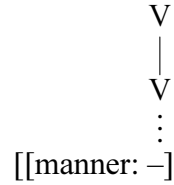
Incomplete structures do not appear to occur in branching constituents. Occurrence in marked syllabic constituents seem to require that the segments are themselves unmarked, hence not degenerate in any shape or form.

6.1 *No manner and no place*

The most extreme form of degeneration is complete emptiness, i.e. absence of all gestures. In this case, what we have is just a syllabic position, i.e. a skeletal position that has no content, i.e. no manner or place properties (as well as no laryngeal properties):

[24] This is one reason for being sympathetic to the DP idea that voicing is a manner property; cf. the discussion in §2.1.1.

(47) *Empty rhyme*

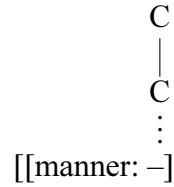
a.


b. * V

Empty rhymes are typically realised as some kind of schwa, or in some languages as a silent allophone in certain environments. In GP these are termed 'empty nuclei';[25] the focus in this approach has been on languages that allow these nuclei to be silent in 'licensed' environments (cf. Kaye *et al.* 1990; Ritter 1995; van der Hulst & Ritter 1999b; van der Hulst, in preparation).

Onset heads can also be empty. In this case the 'syllable' behaves as if it has an initial consonant, while none is audibly present. This is used for the characterisation of *h-aspiré* in French, and similar 'silent' consonants in other languages. Whereas empty-headed rhymes need to be licensed to be silent, no such condition holds for empty-headed onsets.

(48) *Empty onset*

a.


b. * C

The need for a 'bare' rhyme node has not been suggested. A bare onset, on the other hand, has been argued to be present when syllables 'start with a vowel' (e.g. in GP). It is uncertain, however, whether a bare onset node is really required in representations. In our notation, a distinction between C(c) (48a) and C (48b) is not possible.

6.2 *Just laryngeal?*

We must now consider the case in which only the laryngeal gesture is present; this is like the previous case, but with the optional laryngeal gesture present. A straightforward account of the laryngeal consonants /h ʔ/ would seem to analyse them as mannerless and placeless, having only a laryngeal specification. However, recall that aspiration and glottalisation are the expres-

[25] As is evident from the proposals in §1.3, I make no distinction between the notion 'nucleus' and 'rhyme'.

sion of an adjunct, rather than of basic laryngeal structure. As an alternative, one might suggest simply using C(c) and V(v), which normally represent voiceless and voiced, to represent /h ʔ/ when the laryngeal gesture occurs alone. However, I suggest that this option should be rejected. One reason for this is that there appears to be no rhymal counterpart to laryngeal consonants. Below we will see that laryngeal consonants can be derived in another way. I thus conclude that structures consisting of only the laryngeal gesture are ill formed. Given that the specifier is inherently optional, this strikes me as a desirable constraint which reinforces the asymmetry between specifiers and complements.

6.3 *Manner but no place*

In the domain of vowels, I suggest that manner-only (i.e. placeless) vowels are non-front, non-rounded (central) vowels. They can be high or low, again the unmarked options. We might assume that this gives us a central high unrounded vowel /ɨ/ and a central low unrounded vowel /a/:

(49) *Manner only* (*rhyme*)
[[manner: C(c)] [place: –]] = /ɨ/
[[manner: V(v)] [place: –]] = /a/

Recall that in §3.1 we used the Vc option for back unrounded vowels (like /ɯ/). A potential problem for the system is that perhaps no contrast between /ɨ/ and /ɯ/ (or more generally between central and back unrounded vowels) is ever needed. RCVP, as it stands, predicts this to be a possible contrast. This problem (if, in fact, the contrast is unattested) has suggested to me in the past that blocking Vc in the vowel place gesture is a good move. However, since such blocking would be achieved by an *ad hoc* constraint (*Vc), no real improvement of the system as a whole results from this move.

For onsets, the placeless option provides a representation for the laryngeal consonants /h ʔ/.

(50) *Manner only* (*onset*)
[[manner: C(c)] [place: –]] = /ʔ/
[[manner: V(v)] [place: –]] = /h/

We now see why velar consonants must be accommodated in the place gesture in terms of Vc, and why the constraint *Vc cannot be generalised to consonantal place: if we use placeless representations for the laryngeal consonants, we cannot use them for velar consonants. Hence velar consonants *must* be accommodated in the place gesture.

The difference between dorsals and laryngeals, then, is that the former have both manner and place, while the latter lack a place gesture. In §8 I will argue that two further classes, namely uvulars and pharyngeals, are dorsals and laryngeals with a 'low' secondary articulation:

(51) a. *dorsal* /x/ *uvular* /χ/
[[manner: Cv] [place: Cv]] + V(v) secondary articulation
b. *laryngeal* /h/ *pharyngeal* /ħ/
[[manner: Cv] [place: –]] + V(v) secondary articulation

This proposal does not explain two things. Firstly, it does not explain why there are no pharyngeal stops, whereas there is a laryngeal stop. Secondly, we do not derive a precise characterisation of the class of gutturals, which included not only uvulars and pharyngeals (both with secondary V(v)), but also laryngeals. The former gap may be due to a phonetically motivated, but phonologically *ad hoc* constraint (cf. note 1). The second problem suggests a re-examination of the participation of laryngeal consonants in the guttural class.

6.4 *Place but no manner*

Let us now consider the option of just place. My suggestion is to attribute this property to both consonants and vowels with 'weak' articulations. For consonants, this would be adequate for a variety of segments types, including taps and flap.[26] We also predict the occurrence of a 'labial' tap/flap, if both unmarked place categories are valid. This is, of course not necessarily the case. If only one tap/flap occurs, we correctly predict it to be coronal, the unmarked place.

What interpretation can we assign to incomplete segments in rhymal position? Mannerless vowels with unmarked place could be the weak vowels in words like *happy* and *hollow*. If this is correct, we can say that, in English, mannerless vowels are unstressable:

(52) *English unstressable vowels*
[[manner: –] [place: C(c)]] = [i] (happ**y**)
[[manner: –] [place: V(v)]] = [o] (holl**ow**)

The other unstressable vowel, schwa, has already been accounted for in (47) as the mannerless, and also placeless vowel.

[26] Lack of manner may also be adequate for unreleased stops, although such segments are not known to be contrastive with released stops.

(53) *Place-only* (*onset*)

a. [[manner: –] [place: C(c)]] = coronal flap/tap
   [[manner: –] [place: V(v)]] = (labial flap/tap?)

b. [[manner: –] [place: C(c)]] = happ**y**
   [[manner: –] [place: V(v)]] = holl**ow**

It appears not to be possible for mannerless structures to have distinctive laryngeal properties.

7. *Complex segments*

This article has alluded to a notion of adjunction in several places. I cannot here give a full account of adjunction structures. I will summarise the instances of adjunction that we have appealed to in an 'idealised' form:

(54)

		host	*adjunct*
a.	manner onset	C(c) 'stop' V(v) 'fricative'	C(c) 'lateralisation' V(v) 'labialisation'
b.	manner rhyme	C(c) 'high' V(v) 'low'	C(c) 'ATR' V(v) 'RTR'
c.	manner syllable	C(c) 'stop' V(v) 'fricative'	C(c) 'dorsalisation' V(v) 'pharyngealisation'
d.	place	all basic places	C(c) 'palatalisation' V(v) 'labialisation'
e.	laryngeal	C(c) 'voiceless' V(v) 'voiced'	C(c) 'glottalisation' V(v) 'aspiration'

(a) I have suggested the need for adjunction of an onset dependent node to an onset head node to account for lateralisation and rhoticisation. We noted that V(v) adjunction would give us labialisation, which, as shown in (54d), can also be accounted for in terms of V(v) adjunction in the place gesture.

(b) I have suggested a need for adjunction of a rhyme dependent node to a rhyme head node in order to account for the ATR and lax. We noted that no language uses both.

(c) I add adjunction of a rhymal manner node to an onset manner node to account for secondary dorsalisation and pharyngealisation, which do not seem to occur in contrast. Here I assume that the host structure is either a stop or a fricative, as in the case of (a).

(d) I have suggested the need for adjunction of a rhymal place node to an onset place node in order to account for secondary articulations (palatalisation

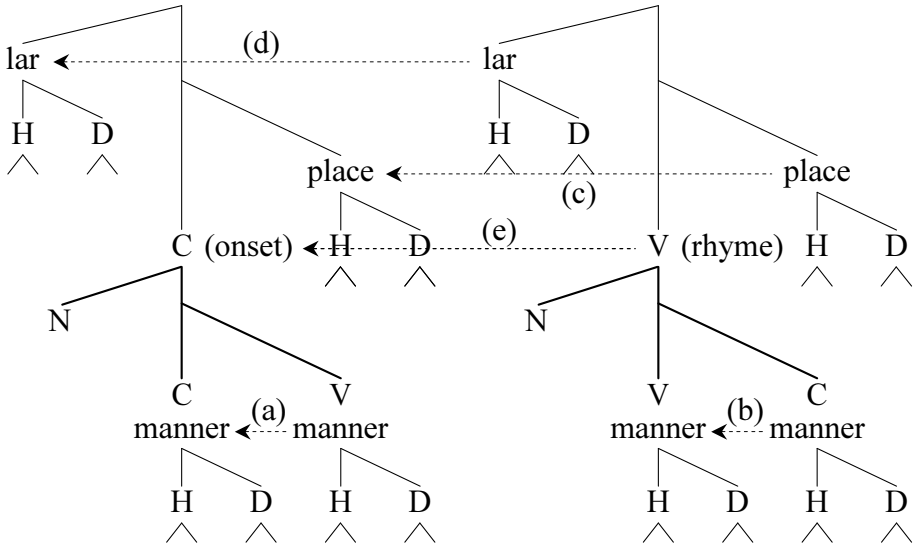
and labialisation). If here, too, the host is unmarked, we predict that only unmarked coronals and labials can have secondary articulations. However, I have already appealed to adjunction for both marked and unmarked coronals. Secondary place articulation apparently allows a greater array of hosts, including the dorsals. Hence all place of articulation seem to be available for adjunction.

(e) I have suggested the need for adjunction of a rhymal laryngeal node to an onset laryngeal node in order to account for the complex phonation types aspiration and glottalisation.

In the first three cases (all manner), it appears that only one of the two options is used in any given language and only with unmarked hosts, while adjunction for place and laryngeal seems to allow both options with reference to marked and unmarked hosts.

The various set of adjunction types give the following:

(55)



In all cases the host and the adjunct tend to be an unmarked basic structure. This could be developed into a formal complexity constraint.

8. *Some correspondences with Government Phonology*

We have seen that all elements can appear in both onset and rhyme positions. Also, we have seen that each element has a variety of phonetic interpretations. The exact phonetic interpretation of these two elements is determined by three factors, as in (8) above.

Given these interpretation rules, we have come to the rather striking conclusion that there are only two phonological elements, labelled, rather arbitrarily, C and V.[27]

(56) *Class node/Element*

Manner	C	V
Place	C	V
Laryngeal	C	V

In comparable frameworks that do not assume a segment-internal tree structure, at least six elements would have to be postulated to achieve the same coverage. Indeed, this comes very close to what we actually find in current versions of element theory within Government Phonology:

(57) *Class node/Element*

Manner/place	?	stop	A	low
Place	I	front	U	round
Tone/nasality	H	high tone	L	low tone; nasality

I give the grouping in binary pairs to bring out the parallelism. No grouping is assumed in GP; this is precisely why it needs six rather than two primitives.

I am not aware of a detailed account of how the six GP primitives can be used to accommodate all the phonological distinctions that are needed. For example, I have not seen a proposal that deals with the more 'exotic' phonation types. This does not imply that this cannot be done, of course. A striking difference between RCVP and GP lies in the fact that GP proponents have suggested that both voicing and nasality can be regarded as exponents of the element L, which otherwise refers to low tone. RCVP does not adopt this idea; instead, N is a separate entity, a specifier, like tonal elements.

Assuming GP type elements, Ritter (1997) proposes to eliminate the manner elements ? and h (an element which had already abandoned by others), replacing them by a contrastive distinction between headed and non-headed expressions. However, Ritter acknowledges a closed counterpart to A, *viz.* @ (formerly called the 'cold vowel'), thus ending up with the following six elements (again arranged to make the comparison easier):[28]

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[27] This is even more so if we consider categories in sign phonology (cf. van der Hulst 2000).

[28] Jensen (1994) also eliminates ? and h, replacing these by extra syllabic organisation. This leaves five elements, A having no counterpart. Ritter's proposal is more interesting than that of Jensen, since it makes use of a distinction (headed ~ non-headed) which is already assumed in

(58) *Class node/Element*

Manner	@	A
Place	I	U
Tone/voice/nasality	H	L

It is presumably not a coincidence that proponents of GP have arrived at a set of elements which could be seen as fully compatible with the RCVP model. This again supports the model proposed here. I claim, though, that the value of RCVP lies in going beyond simple listing of the six elements by deriving this set from more fundamental principles.

It is not my task to comment on these different varieties of GP's element theory. However, it seems obvious that both RCVP and GP have converged on a very similar set of primitives, the major difference lying in RCVP's use of structure. GP proponents do not completely rule out the use of structure. Harris & Lindsey (1995:76), for example, invoke an intrasegmental structure that is reminiscent of the split between laryngeal, manner and place. In the domain of 'complex segments', GP proponents have suggested the use of 'adjunction' as a tool to represent a mode of combination that differs from the combination mode that delivers 'basic structures'.

9. *Conclusions*

This article has outlined an approach to segmental (and syllabic) structure that develops some of the basic ideas of Dependency Phonology. My goal has been to design a restrictive system that accounts for all and only the phonological distinctions that are needed in the (spoken) languages of the world. Needless to say, much work remains to be done, especially in the area of providing empirical support for some of the particular structures. However, I claim that much has been achieved. RCVP makes an offer that is hard to refuse. It reveals a structure that is hidden below the surface of feature theories, both in terms of the choices for features and their 'geometrical grouping'. It makes use

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GP work in order to separate ATR from RTR vowels (Kaye 2000). In Ritter's proposal obstruents are distinguished from sonorants in terms of the presence of a laryngeal element:

Headed	*Non-headed*	
Vowels	ATR	RTR
Obstruents (H,L)	Stops	Fricatives
Sonorants	Liquids	Approximants

In this proposal it needs to be made clear how further necessary distinctions will be expressed. In any event, the correspondence that stands between Ritter's theory and RCVP is that in each case that she uses a headed representation, RCVP uses a 'C-choice'.

of formal apparatus that most theories use (building blocks, grouping and dependency), but restricts all of these in principled ways. RCVP does not overgenerate more than other theories usually do; in fact, it allows the formulation of principled rather than *ad hoc* constraints that refer to the CV 'encoding' of the phonological categories that may or may not be combined.

It seems to me that no serious theory of phonology can be satisfied with a mere listing of its primitives and structures in the face of an alternative that explains the list and the structures. Dependency Phonology offers all the tools to develop interesting methods of going beyond stipulative accounts of phonology, not by rejecting their major results but by going deeper and finding formal explanations for recurrent patterns.

The present system is clearly not perfect. I have hinted at various points where problems exist or alternatives might be considered. Exploration of these alternatives sometimes leads to unexpected results that suggest revisions in other parts of the system. In the end one has to *believe*, I suppose, that an enterprise like this is worthwhile, and that there indeed is a principled hidden cognitive structure behind the somewhat chaotic diversity in the phonetic exponents of phonological contrasts.

Appendix I: The interpretation of gestural occurrences of C and V

Format: [A [manner: B]]

A = syllabic position (C = onset head, V = rhyme head, Xy = onset or rhyme dependent); B = element as head (C or V) or as dependent (Xc or Xv). The phonetic gloss applies to the bold occurrence of C/c and V/v.

Manner		**Place**	
[C [manner: **C**]]	= stop	[C [place: **C**]]	= lingual
[C [manner: **V**]]	= fricative	[C [place: **V**]]	= peripheral
[C [manner: X**c**]]	= non-strident	[C [place: X**c**]]	= non-labial
[C [manner: X**v**]]	= strident	[C [place: X**v**]]	= labial
[V [manner: **C**]]	= high	[V [place: **C**]]	= front
[V [manner: **V**]]	= low	[V [place: **V**]]	= back
[V [manner: X**c**]]	= high	[V [place: X**c**]]	= non-round
[V [manner: X**v**]]	= low	[V [place: X**v**]]	= round
[Xy [manner: **C**]]	= liquid		
[Xy [manner: **V**]]	= approximant		
[Xy [manner: X**c**]]	= lateral/[j]		
[Xy [manner: X**v**]]	= rhotic/[w]		

Laryngeal

[C [laryngeal: **C**]]	= arytenoids open	[V [laryngeal: **C**]]	= h (high register)
[C [laryngeal: **V**]]	= arytenoids closed	[V [laryngeal: **V**]]	= l (low register)
[C [laryngeal: X**c**]]	= stiff vocal cords	[V [laryngeal: X**c**]]	= H tone
[C [laryngeal: X**v**]]	= slack vocal cords	[V [laryngeal: X**v**]]	= L tone

Appendix II: The interpretation of gestural occurrences of C and V

Manner	*onset head*		*nucleus head*	
	C	V	C	V
head status	stop	fricative	high **dorsal**	low **pharyngeal**
dependent status	non-strident	strident	high	low
specifier	nasal			nasal
Manner	*onset dependent*		*nucleus dependent*	
	C	V	C	V
head status	liquid **lateral**	approx. **labial**	liquid **RTR**	approx. **ATR**
dependent status	lateral/[j]	rhotic/[w]	lateral/[j]	rhotic/[w]
Place	*onset head*		*nucleus head*	
	C	V	C	V
head status	lingual	peripheral	front **palatal**	back **labial**
dependent status	lingual	labial	front	round
Laryngeal	*onset head*		*nucleus head*	
	C	V	C	V
head status	aryts. open	slack vocal cords	high reg. **glottal**	low reg. **asp.**
dependent status	aryts. closed	slack vocal cords	H tone	L tone

The boldface glosses apply to the gestural elements as adjuncts.

Appendix III: The interpretation of syllabic occurrences of C and V

[**C**]	=	[+consonantal]	[**V**]	=	[+sonorant]
[C**c**]	=	[–sonorant]	[V**v**]	=	[–consonantal]
[C**v**]	=	[+sonorant]	[V**c**]	=	[+sonorant]

Appendix IV: The interpretation of syllabic structures

C(c) = [–sonorant, +consonantal] (obstruent)
Cv = [+sonorant, –consonantal] (sonorant consonant)
Vc = [+sonorant, –consonantal] (sonorant consonant)
V(v) = [+sonorant, –consonantal] (vowel)

Appendix V: The interpretation of gestural structures

Manner	*onset head*	*onset dependent*	*nucleus head*	*nucleus dep.*
C(c)	stop	/l/ **lateral**	high **dorsal**	/l/ **ATR**
Cv	$\text{stop}_{\text{strident}}$	/r/	high_{mid}	/r/
Vc	fricative	/j/	low_{mid}	/j/
V(v)	$\text{fricative}_{\text{strident}}$	/w/ **labial**	low **pharyngeal**	/w/ **RTR**
Place				
C(c)	lingual	—	front **palatal**	—
Cv	$\text{lingual}_{\text{dorsal}}$	—	$\text{front}_{\text{round}}$	—
Vc	$\text{peripheral}_{\text{lingual}}$	—	$\text{back}_{\text{front}}$	—
V(v)	$\text{peripheral}_{\text{labial}}$	—	$\text{back}_{\text{round}}$ **labial**	—
Laryngeal				
C(c)	aryt. open	—	H reg_{H} **glottal**	—
Cv	aryt. $\text{open}_{\text{slack}}$ (breathy)	—	H reg_{L} (high mid)	—
Vc	aryt. $\text{closed}_{\text{stiff}}$ (creaky)	—	L reg_{H} (low mid)	—
V(v)	aryt. closed	—	L reg_{L} **aspirated**	—

The boldface glosses apply to the gestural structures as adjuncts.

Appendix VI: The interpretation of incomplete structures

[[–] –]	=	[ə]	(empty, i.e. mannerless and placeless)
[[manner] –]	=	[ɨ], [a]; [ʔ], [h]	(placeless)
[[–] place]	=	[ɪ ʊ]; [ɾ]	(mannerless)