A Guide to Radical CV Phonology, with special reference to tongue root and tongue body harmony

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1 Introduction

My goal in this article is contribute to the discussion about different perspectives on element theory. To this end, I provide an outline of my perspective, which is captured in a model that I have been developing over many years, called Radical CV Phonology (RCVP). This model covers segmental structure as well as syllabic structure. A book-length exposition of this model is offered in van der Hulst (2020), to which I must refer readers for more details, and empirical support from typological studies on phonemic contrast, as well as insights that the model provides about affinities between traditional features that are usually captured in terms of stipulative redundancy rules.[1] Such affinities are 'built in' into the model, which uses only two elements that, given their structural position in an intrasegmental dependency structure, express all 'features' that are necessary to capture all phonemic contrasts that have been attested. While this chapter contains a brief comparison between RCVP and two other models (Contrastive Hierarchy Theory and versions of Government Phonology), the book devotes a chapter to comparison to many other theories of segmental structure. I also show in this book how the principles of RCVP can be applied in the domain of sign phonology. An extensive application of how the model can deal with vowel harmony systems can be found in van der Hulst (2018), which combines the RCVP perspective on vowel structure with a notion of licensing of 'variable elements' to account for vowel harmony patterns in both relatively simple and more complex cases that involve transparent and opaque vowels. Inevitably, the model has gone through different versions. This article is faithful to the 2020 version, with the exception of how I here propose to deal with distinctions that are traditionally captured by features such as [ATR], [RTR], [low and high]. Section 2 briefly states my background assumptions about some central issues in phonology. Section 3 then provides an outline of the RCVP model. Sections 4 and 5 discuss comparisons with Contrastive Hierarchy Theory and Government Phonology. In section 6 I consider some alternatives to the 2020 model with regard to tongue root distinctions. I offer some conclusions in section 7.

2 Basic assumptions

2.1 What does phonology cover?

Phonology studies the truly observable (indeed perceived) level of languages with full consideration of the articulatory and psycho-acoustic properties –which is often referred to as 'phonetics'– but also mind-internal levels, including one which represents only those properties of the signal that are 'linguistically relevant' or contrastive, and thus 'phonemic'. I assume here that an additional shallower, i.e. more fully specified level (which I call the *word level*), is also required. The minimally specified level and the word level form what I call the grammatical phonology. I assume here that *grammatical phonology* is related to the

[1] See https://edinburghuniversitypress.com/book-principles-of-radical-cv-phonology-hb.html.This article is based on a presentation at the conference: Elements – State of the Art and Perspective, held in Nantes (France) on June 14-17, 2018.

perceived signal and the articulatory actions on the one hand and the shallowest internal representation (which I call *utterance phonology*, which is 'post-grammatical') by a system of phonetic implementation.

2.2 Five theses concerning phonological primes[2]

2.2.1 Are features based on perception or articulation?

I suggest a compromise view and argue that there is no need to exclude articulation from the grammar (as is assumed explicitly in Government Phonology), but rather that both acoustics and articulation deliver cognitive substances that provide the 'raw material' that phonological elements categorize. To include articulation as a cognitive substance, we do not have to rely on the motor-theory of speech perception. I hypothesize that, alongside percepts of the acoustic speech signal, speakers also have *proprioceptions*, which refer to the sense of the relative position of one's own body parts and strength of effort needed for their movement.

2.2.2. Are features innate?

Adopting the view that features are responsible for allowing the expression of contrast, I suggest that features for spoken languages and for sign languages (or for any other modality that can be used for the expression of a human language) are not innate but instead result from an innate categorization principle that splits phonetic substances into two opposing categories. Van der Hulst (2015b) calls this the *Opponent Principle.* This principle need not be thought of as being specific to language, being part of the capacity that is called categorical perception.

2.2.3 Are features, or is phonology in general, substance-free?

I assume with John Anderson (Anderson 2011) that features are substance-based, arising during the process of language acquisition, based on perceptions of the acoustic signal (to which I add proprioceptions) and guided by the recursive splitting process. I therefore would not accept features that are 'purely abstract' (that are phonetically 'meaningless', as proposed in Foley (1977)), nor that structures can arise that are 'phonological unicorns', i.e. structures that are not phonologizations of actual phonetic events that occur in human languages. The substance-based approach that I adopt apparently stands in contrast to so-called substance-free theories proposed in Hale & Reiss (2000) and Blaho (2008), but there is no disagreement about the fact that (grammatical) phonology makes no direct reference to phonetic substance.

2.2.4 Are phonological representations fully specified?

I adopt Anderson's view that phonological representations are minimally specified and that the criterion for specification is *contrast.*[3] Using unary elements dramatically reduces the need for underspecification, but this notion is still relevant if only contrastive element specifications are postulated in lexical representations (see van der Hulst (2016,

[2] This section is based on van der Hulst & van de Weijer (2018) and van der Hulst (2020: chapter 1).
[3] See Dresher (2009) for a perspective on minimal specification using binary features; see section 3.

2018)), which means that we need a system that recognizes only contrastive elements. However, minimal specification does not entail a system of rules that fill in redundant information. I assume that minimally specified representations are mostly directly phonetically implementable and implemented, albeit with the intervention of *enhancement rules* that may activate redundant elements at the word level (see van der Hulst (2015a, 2018, 2020).

2.2.5 Is there such a thing as a segment inventory?

Anderson assumes that contrast (and ultimately the notion of segmental inventory) is relative to syllabic positions and refers to this as the idea of *polysystematicity*, a view originating in Firth's prosodic phonology (Firth (1948)), which rejects the notion of a phoneme as a unit that generalizes over sets of segments that occur in different syllabic positions (unless the contrastive possibilities are exactly the same). I am doubtful that there would be no 'reality' to a unifying notion of say, the phoneme [l] (as a unit that subsumes the l-sounds in English *lip*, *blink*, *silly*, *health, already* and *pill*, which all differ in phonetic details, being, as such, in complementary distribution), despite the fact that phonemes will not be specified with the same degree of complexity in all positions in lexical entries, because minimal specification will indeed require that in positions in which there is neutralization of contrast fewer specifications are necessary. For example, in *blink*, [l] only contrasts with [r], whereas in final position it contrasts with a much larger set of segments, at least in English. I suggest that this would not prevent the adoption of a unified phoneme /l/ as a psychologically real entity, but I do see the 'danger' that such a notion can be reinforced, some would say created, by the adoption of a spelling symbol <l> for all of them; see Anderson (2014).

2.2.6 Is phonology different?

Fundamental to Anderson's work is the *Structural Analogy Assumption*, which holds that structural relations and principles are the same in both planes of grammar, syntax and phonology. The planes therefore primarily differ in terms of the sets of their basic units, i.e. their alphabets, which are determined by the interface with phonetic substance (for the expression plane) and conceptual meaning (for the content plane). The assumption of structural analogy has roots in Louis Hjelmslev's theory of glossematics (e.g. Hjelmslev (1943 [1953])). It might seem that this assumption runs counter to the modularity assumption that is prevalent in Generative Grammar (and Cognitive Science in general), but this is only true if we assume that recognizing different modules (of grammar or of the mind) somehow entails that these modules must have radically different internal organizations. I suggest that the opposite is more likely, allowing the mind to use the same 'tricks' in different modules, perhaps as many as possible, even across very different cognitive domains.

3 An outline of Radical CV Phonology

Radical CV Phonology is a theory of segmental and syllabic structure. Based on a series of previous articles, notably van der Hulst (1995, 2005), it is fully developed in van der Hulst (2020), henceforth VDH20, on which this section draws heavily.

3.1 Segmental structure

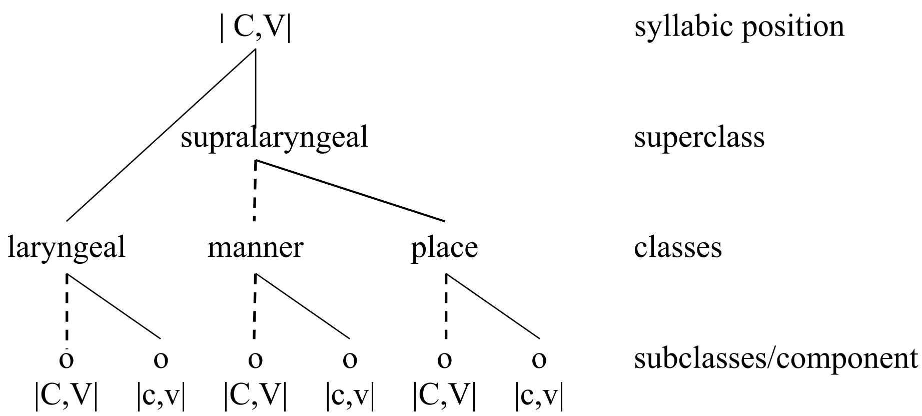
Roughly, RCVP shares its basic principles, as expressed in (1), with Dependency Phonology (DP) which introduced at least six important innovations, several of which date back to early publications by John Anderson and Charles Jones (Anderson & Jones 1972, 1974):[4]

(1) Fundamental principles of RCVP:
a. Phonological primes are unary (they are called *elements*[5])
b. Elements are grouped into units ('gestures' or 'class nodes')[6]
c. Each class is populated by the same two elements, C and V
d. When combined, elements enter into a head-dependency relation
e. All elements are used for both consonants and vowels
f. Some primes may occur in more than one class
g. Representations are minimally specified

The idea to use only two elements, C and V, is the hallmark of RCVP, although the seeds for using the same elements in different element classes were clearly planted in Anderson and Ewen (1987). RCVP takes this idea to the extreme.

In (2) I represent the full RCVP geometry:[7]

(2) The 'geometry' of elements in RCVP



- Vertical broken lines dominate heads.
- Vertical closed lines indicate subjunction (showing the same unit to be a head at multiple levels).
- Slant lines connect dependents to their heads.

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[4] A prepublication appeared in 1972 in *Edinburgh Working Papers in Linguistics*. This paper did not propose the second principle in (1), which was introduced later, following Lass & Anderson (1975).

[5] DP uses the term *component*, but I adopt the GP term element. Schane (1984) uses the term *particle*.

[6] The idea of acknowledging element classes occurs in the earliest version of DP (e.g. see Anderson & Jones (1974)). The same idea later led to versions of what was called 'FG' (see Clements (1985)). In van der Hulst (2020, chapter 11) I discuss various FG models.

[7] The left-to-right arrangement in this diagram does not imply any notion of linear order. This geometry deviates somewhat from the one adopted in AE and bears a close resemblance to the original geometry that was proposed in Clements (1985). In chapter 11 this model is compared to other models with which it shares certain properties. The notation |C,V| or |c,v| stands for 'C or V'; it does *not* represent a combination of C and V. In § 2.3 I discuss the question as to whether we need a separate C/V characterization for major class distinctions. For the moment I will assume that these distinctions are encoded in terms of the syllabic structure.

I will refer to element specifications in head subclasses as primary specifications and specifications in the dependent class as secondary specifications.[8] Both subclasses contain the two elements C and V; for convenience, the elements in the dependent are given in lower case when we explicitly consider them in secondary subclasses; when I refer to elements in general I will use upper case. Within each class, elements can occur alone or in combination (with dependency). A general characteristic of elements that are heads is their perceptual salience.

The motivation for regarding manner as the head class comes from the fact that manner specifications, specifically primary specifications, are determinants of the syllabic distribution of segments and of their sonority (which is of course related to syllabic distribution). Their relevance for sonority also correlates with the role of heads in perceptual salience. Additionally, taking mobility ('spreadability') to be characteristic of dependents, I suggest that relative stability (resistance to 'spreading') is also a sign of heads.[9] This same criterion then also motivates the laryngeal and place classes as dependent classes, given the 'mobility' of laryngeal elements (specifically tone) and place elements.[10] Another property of heads is obligatoriness. All segments thus must have a manner property. The laryngeal class is taken to be the outer dependent ('the specifier' in the 'X-bar' type of organization in (2)) because of its greater optionality (especially when interpreted as tone) and its greater mobility than the place elements, again clearly evident not only from the mobility of tonal elements, but also from phonation properties like voicing. Clements (1985) also proposed the three classes that RCVP acknowledges, with the same grouping of the classes, albeit without imposing a head-dependency relation. In later work in 'FG' the manner node was removed on the argument that there are no processes that treat manner features as a group (see, e.g. McCarthy (1988)). However, group behaviour can also be demonstrated by relevance to phonotactic distribution and in this respect manner features do act like a group. I thus reject the argument that only 'processes' support grouping which it typical of work in the FG-tradition.[11]

While (2) contains labels for element classes, a proper representation of segmental structure can omit all the labels that were provided in (1); that is, the various labels for the classes are for convenience only, having no formal status in . Each unit in the structure can be defined in purely structural terms:

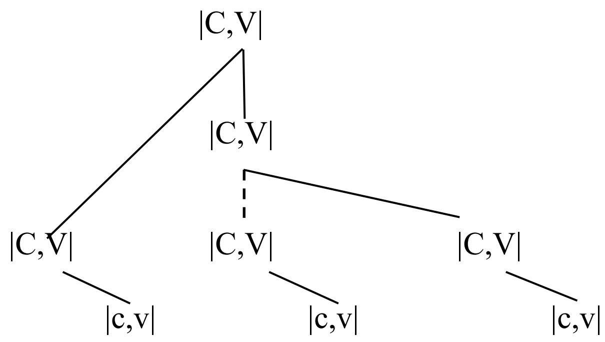
[8] Since in § 4.2 I makes some comparisons between RCVP and Government Phonology (GP), I note here that in terms of formal power, one might argue that GP's distinction between headed and non-headed elements is comparable to RCVP's distinction between primary and secondary elements. However, the details of how these distinctions are applied to distinctive properties are very different.

[9] See Gordon (2016, chapter 6) for a study showing that spreading processes involving major class or manner features are rare.

[10] In autosegmental approaches, mobility amounts to 'spreading' (adding association lines). My own approach to mobility in as far as it falls within phonology proper uses the notion of licensing (of variable elements); see van der Hulst (2018).

[11] In fact, if automatic processes are accounted for in the phonetic implementation, their relevance for grouping is dubious.

(3)



It is important to see that (2)/(3) is meant as a pure dependency structure and thus not as a constituent structure, in line with the essence of dependency grammar approaches which replace constituency by head-dependent relations, rather than augmented the latter to the former.[12]

The two elements C and V[13] (upper or lower case) are strictly formal units, which, depending on their position in the segmental structure (and their role as head or dependent), correlate with specific phonetic properties (as encoded in a set of interpretation functions; see (9) below). Additionally, their interpretation is also dependent on the syllabic position of the entire segmental structure, which means that both elements have different (albeit related) interpretations for each syllabic position in all three classes. The choice of the symbols ('C' and 'V', rather than, say 'ℵ' and '℘') for the two basic primes is motivated by the fact that within each class node, one element is favoured in the syllabic onset head position (the preferred locus of Consonants), while the other is favoured in the rhymal head position (the preferred locus of Vowels). In other words, the labels are mnemonic aids to the traditional idea that consonants and vowels are optimal segments in onset and rhymal head positions, respectively. (In § 2.2, I show how the C/V notation extends to syllable structure.) Since vowels are more sonorous than consonants and thus have greater perceptual salience, we can interpret the C/V opposition as standing for relative perceptual salience, with V indicating higher perceptual salience. Indeed, this interpretation of the element opposition makes the C/V labelling notation arbitrary, which becomes especially clear when I apply RCVP to sign language phonology (see VDH20, chapter 10). Nevertheless, I will continue to use the C/V labelling, having taken note of the notational arbitrariness.

It cannot be left unnoticed that RCVP derives the traditional classes of 'features' (laryngeal, manner, place and major class) from an 'X-bar' type macrostructure. I speculate that this particular organisation, which appears to be shared between (pre-Merge versions of) syntax and phonology, in which heads can have two types of dependents ('complements' and 'specifiers/modifiers'), is perhaps not accidental, but rather reflects a 'deep' structural analogy between syntax and phonology; see den Dikken & van der Hulst (2020) for a strong defence of this view. X-bar theory was introduced as a constituent-based theory, augmented with the notion of headedness; see Kornai & Pullum (1990) for a critical discussion of some aspects of this idea, albeit with acceptance of the central notion of headedness. Following DP, the head-dependency relation in RCVP is seen not as an augmentation of a constituent structure, but rather as replacing constituent structure. Nevertheless, to distinguish between two types of dependents, a similar claim to that of X-bar theory is being made.

[12] It is worth pointing out that in a dependency approach (which does not recognise constituents) there is no distinction between 'merging' and 'labelling'. In a dependency approach, the unit that a dependent adjoins to is automatically the head of the construction, which thus has the identity of the head unit. The issue of labelling simply does not exist in a dependency approach and is thus a non-issue.

[13] When referring to these two elements, I will *not* consistently place them between vertical lines.

Within each of the six subclasses in (2), in principle, an element can occur alone or in combination. This allows for a four-way distinction in which two structures are formally complex in combining two elements that enter into a dependency relation:[14]

(4) C C;V V;C V

In earlier accounts of RCVP, I would say that the maximal set of four structures results from a two-way (i.e. recursive) splitting of the phonetic space that correlates with a phonological element class:

(5) a. ‘phonetic space’

C		V		first split
C	V	C	V	second split

b.

C	C;V	V;C	V	RCVP notation

The first split produces two opposed categories that can be characterised with a single element, C or V. For example, in the head manner class for onset heads (when occupied by obstruents[15]), this split would produce stops and fricatives. A second split creates two ‘finer’ categories, one of which is characterized by an element combination. For example, still within the same class, a second split of the C category delivers plain stops, C, and fricative stops (affricates), C;V.

Even though this notation has intuitive appeal, it is important to note that this two-way splitting diagram is *not*, as such, part of the representation of the segmental structure. It merely depicts how the splitting procedure *recursively* delivers four potentially distinctive phonetic categories that are formally represented as a single C or V or as combinations of these two elements, with a dependency relation imposed. Recursive splitting is due to what van der Hulst (2015b) calls *the Opponent Principle*. This principle (which is rooted in categorical perception; Harnad (1990)) directs a specific categorisation of phonetic substance that ‘produces’ feature systems for spoken and signed languages in the course of ontogenetic development.[16]

Assuming that each subclass in (1) correlates with a ‘phonetic space or dimension’, C and V correlate with (and phonologize) opposite phonetic categories within such a dimension. The opposing categories comprise two non-overlapping ‘intervals’ within which certain ‘prototypical’ phonetic events are optimal in terms of achieving maximal perceptual contrast with minimal articulatory effort.[17] While the elements are thus strictly formal cognitive units, they do correlate with phonetic events (or phonetic categories, covering a subrange of the relevant phonetic dimension). In fact, we can think of elements as

[14] Following DP (Anderson and Ewen 1987) ‘x;y’ indicates that x is the head and y is the dependent. Other notational convention to distinguish heads from dependents have also been used, e.g., x⇒y. In Government Phonology, the head is underlined: ‘x,y’.

[15] In § 2.2 discuss the theoretical position which allow only obstruents in the onset head position.

[16] Theoretically, each of the four categories could be split once more into two opponent categories. The phonetic differences between categories would then become very subtle and it is apparently the case that natural languages do not require going into such subtle differences to achieve phonemic contrast. Additionally, it may be that such subtler differences will be increasingly hard to distinguish perceptually, and to make articulatorily. For this point and some additional discussion of the four-way split, I refer to VDH20:86.

[17] A phonetic category thus has a prototype character with optimal members, prototypes, and suboptimal members. This prototype functions as a perceptual magnet; see Kuhl (1991).

(subconscious) cognitive percepts and propriocepts that correlate with such phonetic categories.[18]

It is important to stress that while the Opponent Principle delivers the maximally opposed elements C and V for each phonetic dimension, it does not as such deliver all the phonological categories that are needed for the analysis of all possible contrasts. For that, we need not only the two opposed elements, but also their combinations. This clearly shows that to explain phonological categorisation more is needed than the Opponent Principle alone. Crucially, we also need a Combinatorial Principle, and, moreover, a Dependency Principle, the last as an obligatory aspect of 'combinations'.

As shown in (2) and (3), the two elements can also occur in a secondary (dependent) subclass in each class, which, if we allow a four-way distinction there as well, leads to the following set of possible structures for each element class:

(6) a. Plane primary (head) structures:

C	C;V	V;C	V

b. Primary structures with added secondary (dependent) structures:[19]

{{C}c}	{{C;V}c}	{{V;C}c}	{{V}c}
{{C}c;v}	{{C;V}c;v}	{{V;C}c;v}	{{V}c;v}
{{C}v;c}	{{C;V}v;c}	{{V;C}v;c}	{{V}v;c}
{{C}v}	{{C;V}v}	{{V;C}v}	{{V}v}

Note that RCVP admits, as one would expect, that the absence of a dependent *secondary* specification can be contrastive with the presence of such a specification. Dependents are never obligatory.[20] The 'option' of having structures that *lack* a head class element, which would create four additional possibilities, is simply not available as part of the RCVP syntax (because dependents cannot be more complex than heads and, moreover, because dependents need a head). As a consequence, elements in dependent nodes can only be activated when elements in corresponding head nodes have been activated.[21] RCVP also rules out a completely unspecified class node as a contrastive option.[22]

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[18] As mentioned in § 1.2.1, I assume that elements have both an acoustic correlate (a percept) and an articulatory plan (a propriocept). We could also call these mental units*concepts*, but because that term is usually associated with 'semantic' concepts, I will use the term *percepts* for mental units that correlate with phonetic substance.

[19] Recall that as a matter of notational convention, I will use lower case symbols for the dependent class elements, following Anderson (2011). I will also use the brace notation when a distinction between primary and secondary elements is made.

[20] In specific segmental systems it is possible in principle that a dependent is 'phonetically' present in a certain class and for a certain segment type, although in such cases the presence of the dependent is always predictable and thus absent in a minimal-contrastive representation. An example would be the requirement that high vowels are advanced. See VHH20, chapter 9 where 'underspecification' is discussed.

[21] The idea that *within a class*, the head component elements must be activated before we get to the dependent elements correlates with the fact that within the segmental structure as a whole the manner class (more specifically its head elements, which account for aperture) must be activated before we get to the place component elements. It has been shown in typological studies of vowel systems that a minimal system would use only manner (i.e. aperture), leading to a so-called *vertical vowel system*, found in some northwest Caucasian languages (Kabardian, Adyghe); see Lass (1984). But there are no vowel systems that only use place distinctions. This further motivates the head status of the manner class (which expresses aperture for vowels and stricture for consonants).

[22] In van der Hulst (2020, chapter 7) I reject the notion of 'empty nucleus', which might qualify as a possible candidate for the representation of a completely unspecified segment.

In (6a), the four-way distinction regards the combinations of elements within the head class, while (6b) represents a combination of each of these four options and one or two elements in the dependent class. The full array of structural possibilities in (6b) is unlikely to be exploited in any language. Moreover, as we will see, there is a strong tendency for the dependent class to only require the two simple structures c and v. The only reason for formally permitting complex dependent structures is that this may be required in the manner class for obstruent consonants and vowels (both syllabic heads), as I show in van der VDH20, chapters 4 and 5. This means that the two middle rows in (6b) are mostly not used. That the dependent class tends to be non-complex can be seen as a trademark of dependent units. As a general head/dependency principle, in any structure, the dependent unit can never be more complex than its head; see Dresher and van der Hulst (1998).

It turns out that structures for vowels are much more restricted than structures for consonants, with one exception. There is only limited use for a dependent class in vowel place, and secondary vowel manner is typologically rare.[23] However, in the case of the laryngeal class, consonants are more limited than vowels. In consonants, as motivated in VDH20, chapter 6, element combinations are excluded in *both* the head and the dependent dimension.[24] For vowels, tonal properties do require combinations of the head laryngeal elements, which can be supplemented by a dependent class element (representing register differences[25]). For these various points about asymmetries between head and dependent structures, I must refer to VDH20.

The fact that combinations are (typically) allowed in head classes but not in dependent classes is perfectly 'natural' in a dependency approach, where, in fact, we expect to find complexity asymmetries between heads and dependents of precisely this kind. As mentioned, heads allowing greater complexity than dependents is a typical manifestation of head/dependent asymmetries. For example, while manner and place allow complex structures in their head classes, this is not required for the laryngeal class, at least for consonants.[26] Both laryngeal and place are dependent classes, but the place class is included in the super class supralaryngeal. Thus, the fact that the place class (especially for consonants) allow more structures than the laryngeal class is, once more, an example of an expected head/dependent asymmetry.

The proposal to represent contrastive segments in terms of element structures does not entail that phonemic[27] contrast must always be represented in terms of different, positively

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[23] The greater complexity of consonantal units is seemingly in contradiction with the head/dependency principle, which precludes dependent from being more complex than heads, since vowels are head of syllables. However, the greater need for consonantal distinctions is motivated by the independent factor that consonants play a greater role in lexical phonemic contrast, i.e. in the identification of differences between morphemes and words than vowels.

[24] Both laryngeal and place are dependent classes, but the place class is included in the super class, supralaryngeal. Thus, the fact that the place class allows more structures than the laryngeal class is, once more, an example of an expected head/dependent asymmetry.

[25] The notion of register has also been invoked to explain the occurrence of four tone heights in Yip (1980). I restrict the use of register to the dependent class elements; see VDH20, § 6.3.

[26] It should be noted that this does not square with the fact that consonants generally allow more contrast. The fact of the matter is that languages can allow a four-way tonal contrast in the primary laryngeal class, especially Asian tone languages. This richness is not matched by phonation contrasts among consonants, at least not given the way in which RCVP represents phonation contrast, where the primary class only contrasts voicing with 'non-voicing' (which I refer to as 'tenseness'); see VDH20, chapter 6 for details.

[27] Since I use the term 'phonological' as comprising the study both of contrastive or distinctive units at the cognitive level and of phonetic categories (as well as the relation between them) at the utterance level, I will often refer to the level of cognitive ('symbolic' or 'formal') representations as 'phonemic', whereas the utterance level will be called 'phonetic'; this follows the terminological practice of American structuralists; see van der Hulst (2013, 2015b, 2016b).

specified C/V structures. One might argue that a strictly minimal way of representing contrast can make use of the ‘zero option’, that is, the absence of an element specification. Thus, a contrast within a given class could perhaps be expressed in terms of C versus zero or V versus zero, and one would expect that this choice would have implications for which category is deemed ‘marked’. For example, if a language has a simple tonal contrast between H (= C in the laryngeal head class) and L (= V in the laryngeal head class), one could conceivably specify only one of them. In many analyses of tonal systems, phonologist have argued that only the H tone is literally marked. I discuss the use of non-specification in this sense in VDH20, chapter 9. However, in RCVP use of the zero option is limited in various ways; for example, the zero option cannot be used in the head manner class, since a manner specification is obligatory for each segment.

While the elements are formal and as such ‘substance-free’, elements do of course correlate with phonetic ‘events’ (phonetic categories); in John Anderson’s terms, the primes of phonology are *substance-based* (see Anderson (2011)); see § 1.2.3. The relation between formal units such as elements and phonetic events is often referred to in terms like ‘phonetic implementation’, although phonetic implementation comprises much more, by also accounting for co-articulatory, allophonic effects. Here I focus on the phonetic correlates of elements as they occur in syllabified segments, assuming that elements, given their structural context, have more or less invariant phonetic correlates.[28] Since the elements C and V occur in many different structural positions, they correlate with several different (albeit related, at least in principle) phonetic events. I will refer to these correlates as the phonetic interpretations or simply correlates of elements; other phonological approaches use the term ‘exponents’. I do not think that it is possible to assign a very global ‘phonetic meaning’ to C and V ‘out of context’. Rather, out of context, these two elements account for a general bias that each occurrence of them shares. The bias of C is that each occurrence of this element is preferred in a syllable position that itself has this label (‘a syllabic onset’) and the reverse holds for the V element (‘a syllabic nucleus’). I will explain this further after having discussed the RCVP account of syllable structure in § 2.2; VDH20, chapter 8 provides a detailed account of this idea of preference. Also, as mentioned earlier, an even more abstract interpretation of the C and V categories refers to their relative perceptual salience, with C being less salient than V.

We will thus see that each of the two elements C and V have a variety of phonetic ‘meanings’ or interpretations, which with a plus or minus value, in traditional binary feature systems are usually associated with different distinctive features, or with opposing unary features or element, such as H (tone) and L (tone). It is in this sense that RCVP provides a ‘metatheory’ of phonological primes, albeit consistently unary primes.[29] Of course, RCVP cannot accommodate ‘all features that have ever been proposed’. My claim is that it accommodates precisely those feature proposals that are the best motivated empirically and therefore most widely used.

In (7), I indicate some of the interpretation functions that assign phonetic correlates to the elements in their various structural positions (here only stated as a mix of articulatory

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[28] One reason for not excluding articulations as correlates of elements is that in several cases, while there is an invariant articulatory correlate, an invariant acoustic property can be hard to find locally in the segment; see Taylor (2006).

[29] That said, RCVP captures the idea of binarity by reducing all contrast to a binary opposition between C and V, whose phonetic interpretations often resemble the interpretation of the two values of traditional binary features. The questions as to how many rimes there are and whether or not they are binary is answered by RCVP as follows: there are only two primes which are polar opposites. This is not the same as having one feature with two values, because the two primes can be combined, where (at least as usually understood) one cannot combine the ‘+’ and the ‘-’ because that leads to a contradiction. That said, one can take C and V to be values of attributes that are captured by the various classes.

terms and, as for the tones, perceptual terms). The inclusion of ‘, onset head’ or ‘nucleus head’ implies that interpretation is dependent not only on the elements subclass (the head class in (7)), but also, as mentioned, on syllabic position:

(7) Phonetic Interpretation Functions for elements in manner (Man) and laryngeal (Lar) *head* classes when occurring in syllabic head positions:[30]

PI (Man: C, head class, onset head)	=	⟦stop⟧
PI (Man: C, head class, nucleus head)	=	⟦high⟧
PI (Man: V, head class, onset head)	=	⟦fricative⟧
PI (Man: V, head class, nucleus head)	=	⟦low⟧
PI (Place: C, head class, onset head)	=	⟦palatal⟧
PI (Place: C, head class, nucleus head)	=	⟦front⟧
PI (Place: V, head class, onset head)	=	⟦labial⟧
PI (Place: V, head class, nucleus head)	=	⟦round⟧
PI (Lar: C, head class, onset head)	=	⟦tense⟧
PI (Lar: C, head class, nucleus head)	=	⟦high tone⟧
PI (Lar: V, head class, onset head)	=	⟦voiced⟧
PI (Lar: V, head class, nucleus head)	=	⟦low tone⟧

The phonetic details of interpretations are, to some extent, language-specific. The property ‘rhotic’, for example, which will be expressed as a manner distinction for *sonorant* consonants, has rather different phonetic manifestations in different languages, so much so that it has been argued that there is no unifying phonetic property. This issue is discussed in detail in Navarro (2018), who makes a convincing argument for the claim that there is nonetheless a unifying phonological representation for this seemingly heterogeneous class of sounds. Another extreme example concerns [[ATR]], which is represented in RCVP by a C element in the dependent place class of vowels (see § 5). Different languages show rather different phonetic correlates of this element, which means that the label ATR is only a rough indication of the articulatory mechanisms that can be involved in expanding the pharyngeal cavity. It has been observed that the acoustic goals of the expanded correlate can be achieved in multiple ways, including lowering the larynx, expansion of the pharyngeal wall or activity of the epiglottis, for example; see Lindau (1979) and Moisik (2013). This specific example is discussed in detail in van der Hulst (2018, chapter 3).

In conclusion, the phonetic interpretation of an element is dependent on:

(8)
a. Being a C or V element
b. Being a head or a dependent in a subclass
c. Occurring in a head or dependent subclass
d. Its syllabic position

[30] I focus here on articulatory interpretations. There are also (psycho-)acoustic interpretations; see § 1.2.1. The ‘⟦…⟧’ indicate ‘phonetic interpretation/implementation’. It cannot escape our attention that the labels for these phonetic interpretations look a lot like traditional binary feature labels, while the use of double brackets is borrowed from a common usage for the representation of meanings that are assigned to syntactic objects.

The reduction of a set of phonetic properties that correspond to different features in traditional feature systems to either C or V is reminiscent of reducing a set of phonetic segments to a single phoneme. Such a reduction (albeit not uncontested; see § 1.2.5) is possible when phonetic segments occur in *complementary distribution*, for instance by occupying different structural positions in the syllable, foot or word. My claim is that the phonetic interpretations of C and V are likewise in complementary distribution. For example, the elements in the head laryngeal class are interpreted as tonal properties when they occur in the syllable head (nucleus), whereas they are interpreted as phonation properties when they occur in the onset head. In this sense tonal properties and phonation properties are in complementary distribution. The idea that tonal and phonation properties are interpretations of the same set of primes was originally proposed in Halle & Stevens (1971), and RCVP accommodates this proposal in a strong form, by claiming that tone and phonation are in complementary distribution.[31] Likewise, in the manner class, stricture in consonants (as captured by the binary feature [±continuant]) is claimed to be in complementary distribution with height (aperture) in vowels.

We expect the different interpretations of elements in different positions to be phonetically related (just as allophones of a phoneme are supposed to be phonetically similar) and we also expect phonological generalisations to express correlations between instances of the same element that occur in different classes and syllabic positions. As an example, I mention the fact that V correlates with the property of being a sonorant in the syllabic V position ('the nucleus'), whereas it correlates with voicing in the laryngeal head class for consonants. The correlation between [+sonorant] and [+voice] has often been noted. It is captured by a redundancy rule in binary systems:

(9) [+sonorant] → [+voice]

In RCVP the same redundancy reflects the general fact that the implied dependency holds between occurrences of the same element in different structural positions:

(10) [Syllabic: V] → [Laryngeal: V]

A similar dependency can be observed between [+high] and [+ATR], which in RCVP are also interpretations of the same element C (in the manner head class and the dependent place class, respectively). It is thus a gain of RCVP that it is possible to reduce to a general format redundancy all statements which in a traditional feature system essentially express random correlations between formally different features, as:

(11) X:α → Y:α

Here 'X' and 'Y' are variables for structural positions, while 'α' ranges over C and V. In VDH20, chapter 9 I present a systematic exploitation of the 'universal redundancy or preference rule' in (11), which expresses what I call Harmony (or Bias).

As discussed in § 1.2.6, a guiding principle of DP is the Structural Analogy Assumption (SAA), which states that representations in phonology and syntax differ mostly due to the fact that these two planes have different sets of basic categories (the so-called 'alphabets'), given that they are grounded in different substances. Since phonology and syntax categorise different cognitive substances (phonetic percepts/propriocepts and semantic

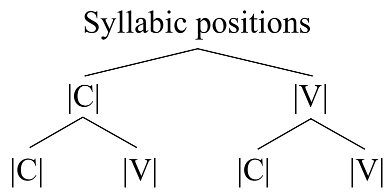
[31] This claim is not without empirical challenges, which I discuss in VDH20, § 6.4.4.

concepts, respectively), we expect their sets of basic categories to be different, both in number and in nature, i.e. what they correlate with. What the SAA states is that phonological structure and syntactic structure display identical *structural relations*, such as, in particular, the relation of dependency between head and dependents, recursion and perhaps also maximal binarity of structure.[32] However, I assume that structural analogy also promotes 'replication' of the same structures *within* planes. RCVP postulates that the various classes within the segment are structurally analogous to the extent that all make use of the same C/V structures (namely those in (8)).

3.2 Syllable structure

Faithful to the basic premise of RCVP, the syllable itself is a combination of a C and a V-unit, which, if no further splitting applies, delivers the core CV syllable structure that is present in all languages. If languages allow a larger repertoire of syllable structures, this results from splitting the C and/or V unit which produces binary branching onsets and rhymes, respectively:

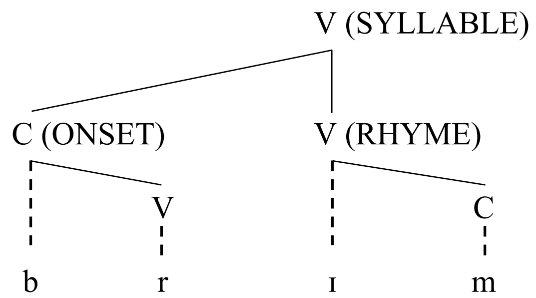
(12)



While the four-way division as such implies no linearization, when combined into a syllable structure, there will be linear sequencing as dictated by some version of the well-known 'Sonority Sequencing Principle' which will require less sonorant segments to precede more sonorant segments in the onset and the reverse in the rhyme unit.

A proper dependency representation of a syllable structure that contains all four syllabic categories is as follows[33]. In (13) I added convenient unit names for each construction and for each of the four segmental positions, but these labels have no theoretical status:[34]

(13) a.



b. EDGE BRIDGE NUCLEUS CODA

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[32] See den Dikken & van der Hulst (2020) for the strong claim that there is only one type of syntax, which generalises over phonology and 'syntax'.

[33] Perhaps there is a resemblance between seeing all syntagmatic relation in terms of dependency and seeing them in terms of 'lateral licensing', as in Scheer (2004), among others.

[34] I assume that syllable structure is recursive, but I do not discuss this here; see van der Hulst (2010, to appear) and den Dikken & van der Hulst (2020).

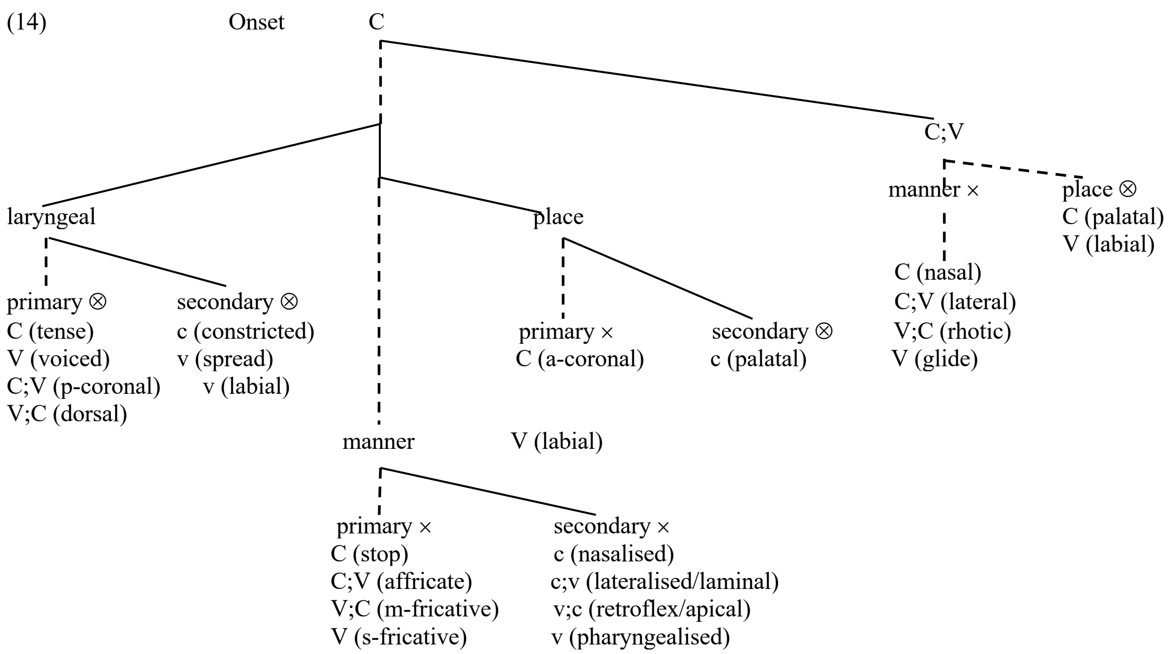
c. obstruents son.cons.vowels son.cons.

In VDH20 I propose that the types of segments that can occur in each syllabic position are determined by the C/V structure of these positions. As indicated in (13c), only obstruents are allowed in onset heads, while only vowels are allow in the nucleus. Both dependent positions only allow sonorant consonants. This proposal makes very strong predictions about the maximal complexity of syllables and which segment types can occur in syllabic positions. Both onset and rhyme can be maximally binary branching. In addition, we disallow onsets consisting of two obstruents, two sonorant consonants and sonorant consonant followed by an obstruent. We also disallow obstruents to function as nuclei and as codas. A similarly strict view was adopted by proponents of GP (see Kaye, Lowenstamm and Vergnaud 1990). I refer to VDH20, chapter 3 for a more detailed discussion of syllable structure, including onsets and rhyme of greater complexity, as well as how to accommodate sonorant consonants as onset head or nuclei; see also van der Hulst (to appear) for an account of recursive structure in onsets and rhyme.

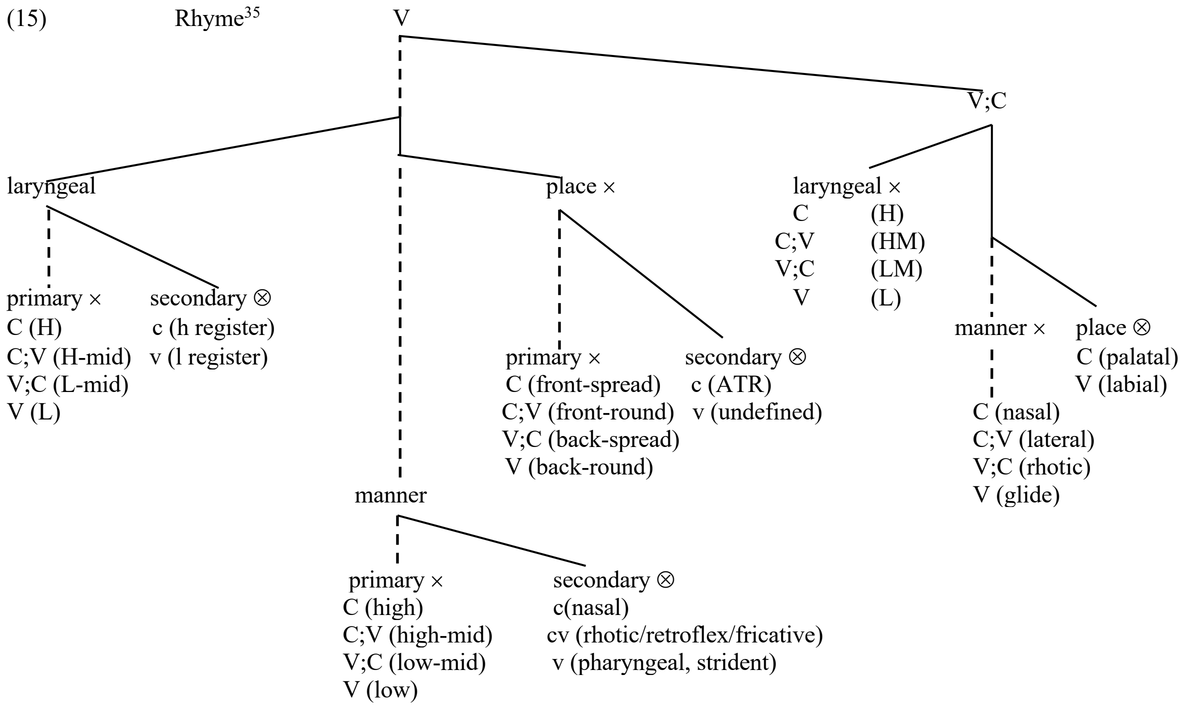
3.3 The full segmental structure

In VDH20 I propose phonetic interpretations for all primary and secondary C/V structures in the manner, place and laryngeal class in all four syllabic positions. I here provide a summary structure for the onset and rhyme positions (omitting some special cases; × = allows combinations; ⊗ = does not allow combinations):

(14)



(15)



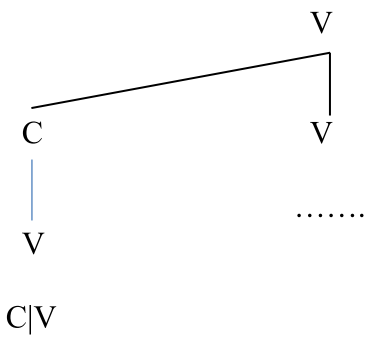
I refer to VD20 for extensive discussion and empirical documentation of all the assigned interpretations which are here given in mostly articulatory terms that resemble traditional binary features in many cases. The structure in (14) and (15) make clear in which sense RCVP can be regarded as a *meta-theory* of distinctive features, here understood as phonetic categories that can be used contrastively. The interpretations for the secondary intermediate cv manner for the rhyme head ('vowels') are especially tentative. In § 5 I single out for further discussion the secondary vowels manners c (nasal) and v (pharyngeal) for discussion, as well as the secondary place specification c (ATR).

While in principle all four syllabic positions could expand the full segmental structure in (13), (14) and (15) show that place and laryngeal specifications in dependent position (bridge and coda) are limited. To account for this, Kehrein & Golston (2004) suggest that place and laryngeal specifications are properties of syllabic units (for them, onset, nucleus and coda). I incorporate this insight by restricting place and laryngeal specifications to onset and rhyme heads (with minor exceptions that I discuss in VDH20). As shown in (14) and (15) the dependent onset and rhyme positions allow limited place specifications and, in the coda, also limited tone specifications, indicated in italic.

(13) seems to restrict the position of sonorant consonant to dependent syllabic positions. But sonorant consonants can also occur as onset or rhyme heads; in the latter case they are called 'syllabic'. In such cases the syllabic structure is as follows:

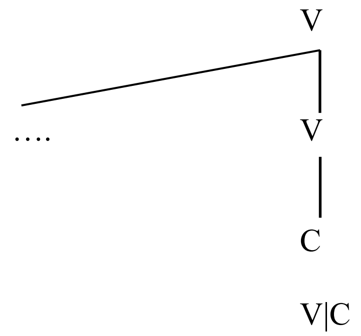
[35]In section 5 of this article I propose an alternative structure for vowel manner and place.

(16) a.



sonorant consonant as onset head

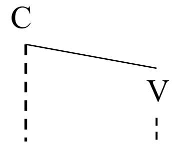
b.



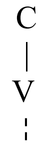
son. consonant as rhyme head,
i.e. 'syllabic sonorant consonant'

The structure in (16a) and (16b) involve *subjunction*, rather than adjunction. A distinction between subjunction and adjunction is permitted in a dependency-based grammar, although it would be formally incoherent in a constituent-based formalism (see Böhm 2018). (17) show the two possibilities for /r/ in onset dependent and onset head respectively:

(17) a.



b.



The structure in (17a) can be mapped on a linearly ordered string (b>r; following the sonority sequencing generalization), whereas the structure in (17b) cannot.

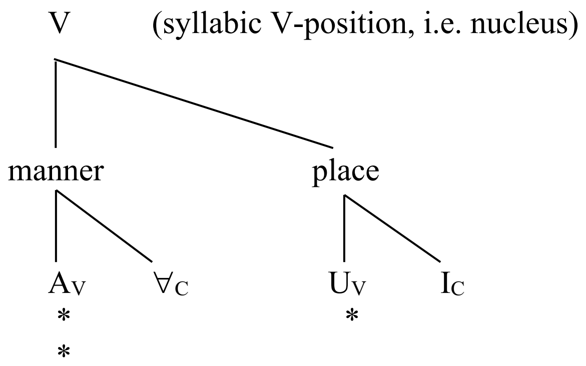
When sonorant consonants occur as head, the manner interpretation are the same as when they occur in dependent positions.

4 The Successive Division Algorithm delivers minimal specification

Dresher (2009) proposes a way of assigning a minimal feature specification to segments based on a *Successive Division Algorithm* that follows a language-specific ranking of features and stops when every segment in the inventory is distinguished from all others. In van der Hulst (2018) I use this algorithm with a *universal* ranking of manner and place elements. This universal ranking is implicit in the structure of the manner and place class and can be derived by assigning an asterisk to each head at both levels within and then differentiate between the dependent elements:[36]

[36]The method for assigning asterisks is the same that Liberman & Prince (1977) propose for deriving a grid from a metrical tree: at the lowest layer assign an asterisk to each head; at the next layers assign another asterisk to the ultimate head of each head, etc.

(18) a.



b. $A_V>U_V>I_C/\forall_C$

In this ranking |I| and |∀| have equal 'prominence'. In van der Hulst (2018: 75) I suggest that "|I|, which denotes a more salient phonetic event, takes precedence over |∀|, unless this element is non-distinctive and/or occurs in a 'mixture' with the U-element (as in Finnish, where [i] and [e] are so-called neutral vowels and front rounded vowels [ü] and [ö] are present)"; see van der Hulst (2018: 88-89) for further discussion. Given the SDA and the universal ranking (per syllabic position[37]), elements will be specified depending on contrast.

If there is no vowel contrast (a frequent situation in unstressed syllable that display complete neutralization of vowel contrast, as in English), the default element is the manner |A| element. |A| is the unmarked choice in a syllabic V-position (i.e. the nucleus) because the syllabic V-position (rhyme head) prefers V-elements (as opposed to the onset head, which is a syllabic C-unit and thus prefers C elements, i.e. stops; see 14).

If a contrast is detected it will be a contrast between |A| and |∀|. A binary contrast within a vowel set, producing a so-called vertical vowel system, is thus a manner contrast; place does not yet come into consideration. Contrast in manner precedes contrast in place (color), which is expected given that manner is the head class. An additional contrast could involve allowing a *combination* of the manner element, creating a vertical vowel system with multiple heights. The other possible route is to introduce color by activating a place element. What happens if the learner is confronted with a low vowel [a] and a high vowel with a specific color (rather than being central, as in a vertical system)? Firstly, we need to consider the possibility that the color is simply a 'phonetic effect', which results in the high vowel being either [u]-ish or [i]-ish. Color could also arise under the influence of neighboring consonants, as has been claimed for Kabardian (Kuipers 1960). We can only be sure that color is contrastively present if there is a color contrast between [u] and [i]. This then implies that we minimally have a three-vowel system [a u i]. We then expect the specification to be as in (19), assuming that the binary color contrast only requires activation of one of the color elements, let us say |U|, because that is a V-type element:

(19)

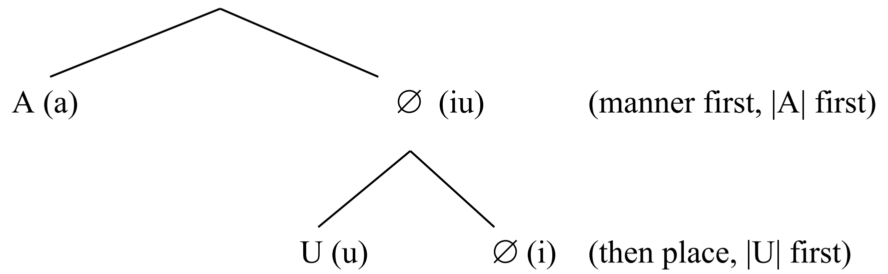
[a]	[i]	[u]
A		
	∀	∀
		U

In (20) and (21), I demonstrate how contrast is minimally specified in a three- and five-vowel system, respectively:

[37] The ranking in (18) holds when elements occur in the V-syllabic unit (the rhyme). In the onset, the ranking would be $\forall_C> I_C> U_V/A_V$, which ranks stops over fricatives and coronal over labials; both rank over dorsals which combine the I and U element; see 14.

(20) A three-vowel system (iua): A > U > I

a.



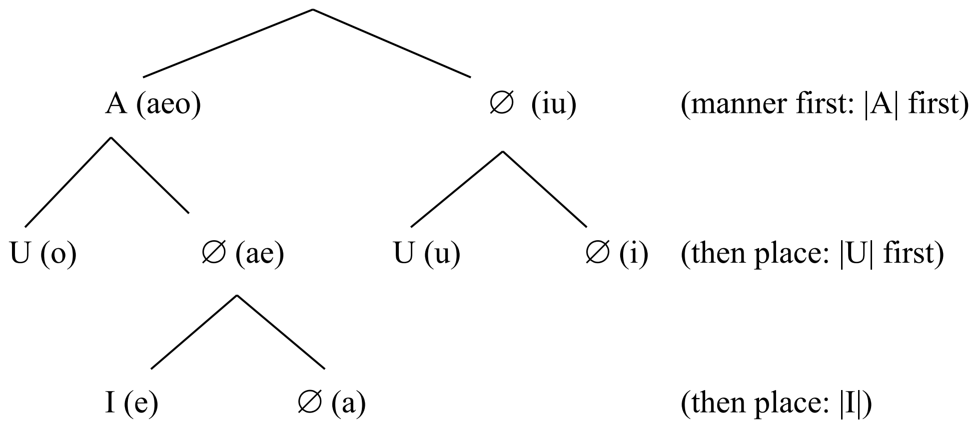
b.

[a]	[i]	[u]
A		
		U

Note that (20b) differs from (19) in omitting a manner element for high vowels. The same result obtains for a five-vowel system:

(21) A five-vowel system (iueoa): A > U > I/∀

a.



b.

[a]	[e]	[o]	[i]	[u]
A	A	A		
		U		U
	I			

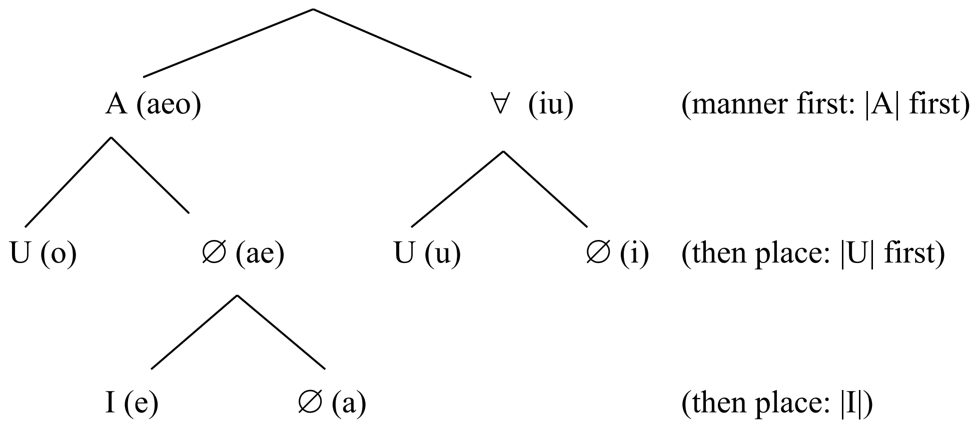
However, we now have to resolve a paradox which goes unnoticed in van der Hulst (2018). The fact that in a three- and five-vowel system high vowels are specified in (20) and (21) *without* a manner element |∀|, means that they are specified without *any* manner element. This seems inconsistent with the claim that manner, being the head class, cannot remain unspecified in a segment. To resolve this problem, I will simply assume that the |∀| is the 'place-holder' element which automatically appears if the manner node is unspecified due to the SDA.[38] The most direct way to achieve this is to say that when the highest-ranking

[38] In this function the |∀|-element is similar to the 'cold vowel' that was used in Kaye, Lowenstamm and Vergnaud (1985), which was in fact similar in terms of its 'phonetic content', being specified in this model as [+high].

element |A| is activated, its antagonistic counterpart |∀| is as well. Thus (21) must be replaced by (22):

(22) A five-vowel system (iueoa): A/∀> U > I

a.



b.

[a]	[e]	[o]	[i]	[u]
A	A	A		
	∀	∀	∀	∀
		U		U

We must note that the 'parsing trees' are not an independent level of representation. They merely depict how phonological segments are minimally represented, given the ranking of elements in (16b). In fact, the parsing tree in (22) is a combination of the recursive splitting diagram that I introduced as showing how learner parse the phonetic spaces that are relevant for phonemic contrast. Rather than following each recursive splitting for all three element classes in sequences (for example Manner > Place > Laryngeal), the available spaces for phonetic contrast are parsed in accordance with a 'Balancing Principle', which favors that the first parse, which is the first manner parse into V (=|A|) vs. C (=|∀|, is followed by the first parse for place (with activating V (=|U|) before C (=|I|)), which for a very complex phoneme system can then be followed by the second manner parse which leads to a combination of |A| and |∀|, plus a dependency relation, and so on. At some point, if the language it tonal, we would expect a tonal element is activated, presumably after vowels have been distinguished in terms or aperture and color.

The RCVP segmental structure and the ranking that can be derived from it thus predicts a learning path. In acquisition, the first step is to assume a *sequential* CV unit (which is already established at the babbling stage), i.e. the syllable. Before any contrast is established, the single segment (that represents all segments in the target language) will have the expected C or V elements, depending on the C or V nature of its syllabic position. In the rhyme unit, the elements that is activated is V (=|A|), which predict that at that point the only vowel will be an [a]-like vowel. When contrast is established this will first activate the C and V element in the head/primary manner, which produces a high/closed vowel and a low/open vowel. When additional contrast is detected this likely (following the balancing principle) involves activated of the place element V (=|U|).

The same parsing logic predicts an 'order' in which attested vowel system increase in complexity:

(23) Ranking:
1-vowel system: A_V (by default)
2-vowel system (no place): A_V vs $\forall_C$
3-vowel system without place: A_V vs $\forall_C > A_V+\forall_C$
3-vowel system with place: A_V vs $\forall_C > U_V$
5-vowel system: A_V vs $\forall_C > U_V > I_C$
More complicated systems: A_V vs $\forall_C > U_V > I_C > A_V+\forall_C$

I refer to van der Hulst (2018, § 2.3) for further details.

5 Comparison to Government Phonology1.0

Having outlined the RCVP model, I will now draw attention to some specific differences between RCVP and (standard) DP and GP, as well as some commonalities. As I will show, there is a sense in which the choice of only two elements in RCVP converges with a particular version of GP that only adopts six elements (as assumed in Backley 2011). Government Phonology, though developed independently from DP, has important characteristics in common with the latter approach.[39]

Later developments in GP were aimed at reducing the number of elements. The overall result of the reduction program was a set of six elements, which Backley (2011) discusses and applies to segmental inventories and processes. He proposes a system of six elements with no further structure imposed on this set; also see Scheer & Kula (2018) and Backley (2011). GP continues to do without any concept of elements grouping. However, in the last chapter, Backley discusses two ways of classifying the six elements.

(24)

variable	relevant values	elements: dark	light
resonance	resonant vs. non-resonant	[A]	[ʔ](~ [∀])[40]
frequency	low vs. high frequency	[L]	[H]
color	dark vs. bright	[U]	[I]

By grouping the elements in antagonistic pairs, Backley says that we reveal "three variables that are even more basic than the acoustic patterns associated with the elements themselves" (p. 195)

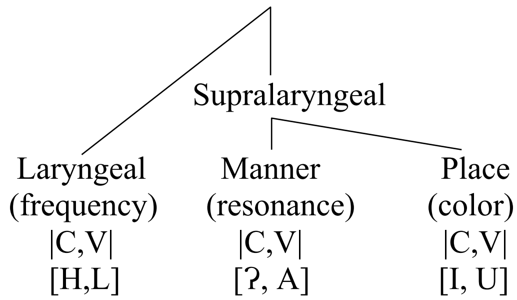
> We can think of the perceptual variables in [(24)] as the fundamental properties of spoken language – properties which humans instinctively pay attention to during communication. Now, because contrast is based on acoustic differences, it makes sense for languages to exploit cues that are maximally different, since these are the easiest to distinguish. The cues that are relevant to phonology are therefore the cues that identify the most extreme values of the three variables. In other words, the elements in each pair are opposites.

[39] I pointed the 'resemblance' out to J.R. Vergnaud in 1982 when he presented these ideas at a GLOW workshop in Paris. A statement in Kaye, Lowenstamm and Vergnaud (1985: 310) that their molecular approach to segmental structure bears some degree of resemblance to earlier work by Anderson and Jones signals an awareness of the similarities.

[40] Instead of 'ʔ' I use the symbol '∀'.

Backley asserts that the variables are not formal units of grammar, nor are the labels ‘dark’ and ‘light’. This is precisely where this model differs from GP element theory. The structure in (25) gives a simplified version of the RCVP structure in (2). Note that the three classes correspond to Backley’s variables (added in parentheses in (25)). Within each class, RCVP will locate the same two elements, C and V, which correlate with different interpretations in each class which expressed that, in Backley’s words: “the elements in each pair are opposites”. This, in a way, delivers a six-way element distinction which corresponds to the six elements that GP ended up with:

(25) The ‘geometry’ of elements in Radical cv Phonology



(|C|~light, |V|~dark)

(Instead of ‘ʔ’ I use the symbol ‘∀)

Backley’s light/dark opposition correlates with the C/V nature of each element. Backley’s reasoning to keep the distinctions in (24) that he recognizes as important outside the formal grammar is not entirely clear to me. I note that if he *would* have added these distinctions to his formal system, his theory would have ended up being nearly identical to the RCVP model. RCVP can reduce the set of six to one pair of opposing elements, because, unlike GP, RCVP formally recognizes the notion of element grouping that Backley refers to as ‘variables’ in (24).

Note that the C/V labeling captures the original insight behind *Charm Theory* (proposed in Kaye, Lowenstamm and Vergnaud (1985): C corresponds to negative charm and indeed: C values are unmarked in onset positions. V corresponds for positive charm, and V values are favored in nuclear positions. The correspondence is not perfect. Kaye, Lowenstamm and Vergnaud (1985, 1990) took U and L to be negatively charmed.

It is also the case that DP and GP make somewhat different usage of the dependency relation. RCVP rigidly applies the head-dependency relation, which means that I do not recognise structures in which elements stand in a relationship of ‘mutual dependency’, as is possible in DP, nor do I use the diacritic headed/non-headed distinction of GP. Thus, I only allow (26a) and (26b) and exclude the possibilities in (24c):

(26) a. A is the head of B.
b. B is the head of A.
c. i. DP: A and B are ‘mutually dependent’.
ii. GP: Elements can be headed or non-headed.

In contrast to (26c), RCVP uses headedness *obligatorily* to acknowledge the asymmetry that arises from merging (maximally two) elements per class node; monoelemental structures are headed by default. Thus, in RCVP, |A| (or its RCVP 'full' equivalent) cannot be distinct from |A̲|, nor is |AI| distinct from either |A̲I| or |AI̲|.[41]

Another apparent significant difference between RCVP and GP (also Backley's version) lies in RCVP's adoption of the element |∀| (although Kaye, Lowenstamm & Vergnaud (1985) originally proposed an element very much like it, |ɨ|, which was abandoned in favor of contrastive use of headedness, as mentioned above). In GP, there is no theoretical reason for pairing up the element |A| with an antagonistic partner, as there is in RCVP. The crucial availability of the element |∀| is supported in van der Hulst (2018). However, as shown in figure 1, the |∀| corresponds to the 'ʔ' elements in GP, so the adoption of |∀| merely makes explicit that the 'closure' element has an equal role to play in vowels (representing high or 'non-low') and in consonants (representing 'non-continuancy'). The |∀| also bears a resemblance to the 'cold vowel' that was proposed in Kaye, Lowenstamm and Vergnaud (1985) in that |∀| is the default manner element that must be present if |A| is not specified, as was discussed in section 3.

Finally, we need to ask whether *elements have an independent realization.* In GP each element is supposed to be independently pronounceable. This means that each element, occurring alone, characterizes a complete segment. While this was certainly also the case in the DP approach, especially for the 'aiu' set, DP does not adopt this requirement for all elements. RCVP takes the view that this property only applies to the *head occurrence* of elements, although it must be added that no head element is interpretable in the absence of a manner element, since manner, being the head of the segmental structure, is an obligatory unit.

6 ATR, RTR and nasality

In this section, I will discuss the representation of tongue root distinctions and nasality and which, for me at least, have always been hard to capture in RCVP in a fully satisfactory way. I have gone back and forth between different proposals. To prove this point, I will here discuss some of these alternatives. By discussing the motivations for choosing between these various alternatives, I hope to give the reader a perspective on the 'logic' of RCVP, that is, the considerations that have led me to embrace certain structures and interpretations, while rejecting others.[42]

In 'older' work on RCVP (e.g. van der Hulst 2005), I have considered the structure in (27), which, using more current terminology, adopts ATR and RTR as secondary manner elements:

[41] This does not preclude leaving the dependency relation unspecified when in a class only one combination of the two elements is needed. If, for example, this concern mid vowels, the dependency is predictable from the phonetic properties of the mid series which can be [e/o] or [ɛ/ɔ].

[42] I realize that some might take going back and forth between alternatives, or find new ones, as a sign of the fact that the RCVP is misguided in trying to 'squeeze' all contrastive phonetic properties in a uniform model that seeks structural analogy between the class nodes, and is based on a few 'first principles'. For me, however, this has always been the most interesting and intriguing part of the enterprise which was led by a conjecture that phonological structure at the segmental and syllabic level (and perhaps higher level too) can be reduced to two basic units which, given their antagonistic nature, are perfectly suited to capture the notion of contrast which is fundamental to the phonology.

(27) V (rhyme)

manner

C (high) c (ATR)
C;V (high-mid v (RTR)
V;C (low-mid)
V (low)

The motivation for taking these interpretations of secondary c and vis that it expresses a direct and formal correlation between tongue height and TR position: high (C) correlates with ATR (c) and low (V) correlates with RTR (v). These correlations are well motivated because high vowels prefer to be advanced while low vowels prefer to be retracted. In VDH20, chapter 8 I show in detail that these kinds of correlations are expected given the RCVP notation. However, there are two problems with (27). Firstly, it does not reserve a place for nasality in the manner class. The class of nasal consonants is represented as C in the manner head class when the segmental structure occurs in the onset dependent position, but that does not account for nasality as a *secondary* property of vowels or consonants. Perhaps, nasality can be expressed elsewhere? GP analyzes nasality as a possible interpretation of the L-element as a dependent, which also covers low tone when it is a head. This would require a revision of the laryngeal class which in VDH20 does not accommodate nasality. A second problem with (27) is that it allows for a contrast between RTR and ATR vowels which remains unattested.[43]

In van der Hulst (2018) I adopt a different proposal which captures the mutual exclusivity of ATR and RTR:

(28) V (rhyme)

manner

C (high) c (nasal)[44] c (ATR)
C;V (high-mid) v (pharyngeal)
V;C (low-mid) v (RTR)
V (low)

Here 'pharyngeal' refers to the pharyngeal cavity, but not specifically to either ATR or RTR, which are taken to be two non-contrastive phonetic choices. The motivation for

[43] Certain Kru languages might qualify, however, for using both ATR and RTR; see Newman (1986) and Singler (2008); but the nature of the vowel contrast and the harmony facts in these languages are not entirely clear to me.

[44] As in DP, nasal(ity) is seemingly expressed twice in the model. However, we need to understand that the manner C element expresses that nasal consonants are stops and not their nasality, which is a side effect given that the nasal cavity is used as an escape route for the egressive airstream. Nasal consonants are universally provided with a secondary manner c element to capture their nasality. This relation is an instance of the universal redundancy rules in (11) which in this case applies obligatorily.

needing both RTR and ATR comes most clearly from a broad typological study of tongue harmony in African languages in Casali (2003, 2008, to appear). Casali convincingly shows that languages with TR harmony in which there is a TR contrast among high vowels are best analysed by taking ATR as the active harmony property. Casali then also argues that languages that only have a contrast for mid vowels require activation of the feature RTR because in those cases the lower mid vowels act as the dominant class; see also Leitch (1996), who confirms this approach in a typological study of vowel harmony in Bantu languages. In van der Hulst (2018: chapter 7) I refer to these findings as 'Casali's Correlation'.[45]

Even though, as shown in Wood (1979, 1982) these two actions involve different muscles: the genioglossus and the hyoglossus, respectively, I proposed that secondary v is phonetically ambiguous, thus allowing the phonetic distinction between ATR and RTR to be a non-contrastive *phonetic split* of the pharyngeal element, with ATR representing a *phonetic* c element and RTR a *phonetic* v element, the choice being determined by the structure of the vowel system, following Casali's Correlation. This proposal then makes the occurrence of ATR and RTR mutually exclusive within a single language.

However, even though in this proposal RTR is available for a language that shows an RTR relation among mid vowels, I actually do not recruit RTR for the analysis of such 7 vowel systems. Rather I proposed that (a) the mid vowels are A-headed (i.e. V;C or A;∀), whereas high-mid vowels are non-headed (CV or ∀A) and that (b) in the presence of low-mid vowels, high-mid vowels will become A-headed, which accounts for the harmony. The argument for representing high-mid vowels as non-headed is that the head manner C element is 'defective', a claim that is motivated at length in van der Hulst (2018)[46], one manifestation of its defectiveness being that it cannot be a head. I here quote from page 244 of that work (section references are to sections in the book):

> I will argue that while we find convincing cases of lowering in terms of licensing of the variable element (A), cases of raising in terms of licensing (∀) are limited. I will show that the element |∀| is regularly involved only if its licensing role is itself licensed by stress. I propose that the rarity of |∀|-harmony is based on a deficiency of the |∀| element, which does not have an independent articulatory correlate. Its presence in the system of elements is enforced by the opponent principle and as such it plays a role in representing mid vowels. From a formal point of view, the deficiency of |∀| lies in its inability to be a head. As a result, this element cannot be a head in a complex aperture structure, as well as in a licensing relation, except when 'fortified' by stress.

The defectiveness of the |∀|-element, which is extensively motivated in van der Hulst (2015), explains why low-mid vowels are dominant, transferring their headedness specification to high mid vowel, this turning them into low-mid vowels.

By adopting the headedness mechanism for harmony among mid vowels in seven-vowel systems and by allowing RTR as a phonetic interpretation of the pharyngeal element, my 2018 model creates an ambiguity in the analysis of such seven-vowel systems. To avoid

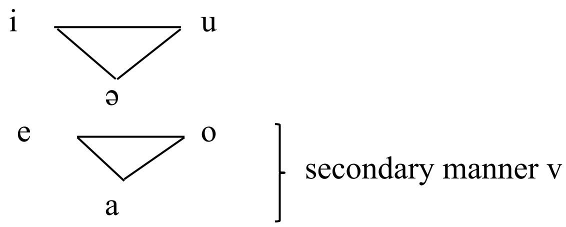
[45] Additional motivation for recognizing both RTR and ATR will be discussed below with reference to vowel harmony patterns in Tungusic and Mongolic languages.

[46] The crucial point is that manner C for vowels does not have an independent phonetic interpretation, there being no articulatory basis for 'high'; see also van der Hulst (2015). The defectiveness of this element is reminiscent of the defective character of the element [ɨ] in Government Phonology (Kaye, Lowenstamm and Vergnaud 1985). In van der Hulst (2018: § 6.6.2.2.2 I make the argument that the ∀ is only involved in stress-dependent harmony (i.e. metaphony).

this ambiguity, I proposed that the choice between RTR as secondary v or a A-headedness depends on the structure of the vowel system.

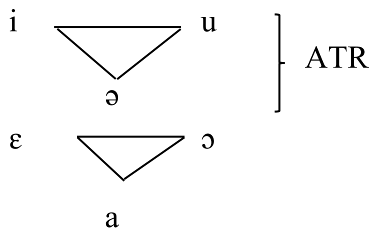
In van der Hulst (2018: § 10.1-3) I discuss a group of languages that have a so-called ‘double triangular system’, for which it has been claimed that RTR is the active and often ‘dominant’ feature in terms of harmony, making them ‘diagonal harmony systems’ (a term used in Kim (1978)). My idea was that only in such language the active harmonic element is RTR as secondary manner v, while A-headedness harmony would apply in seven-vowel systems with two series of mid vowels. An example of a double triangular systems with RTR dominance is Nez Perce:

(29) double triangular system (Nez Perce)



However, the prediction that double triangular system will select secondary manner v as the active element is contradicted by vowel harmony in Gaam [tbi] (Eastern Sudanic, Eastern Jebel in Sudan) as reported in Kutch Lojenga (to appear), based on Stirtz (2009).[47] This language has six contrastive vowels and an active dominant/recessive vowel-harmony system with ATR dominance. The vowel system is as follows:

(30) double triangular system (Gaam)



The following examples (31) to (33) of left-to-right and right-to-left spreading are from Stirtz (2009: 78 and 79):

[47] This report is based on data from Stirtz (2009).

(31) Rightward spreading to plural suffix ***-ɛɛg***, which changes to ***–iig*** after [+ATR] roots.

Noun SG	Noun PL				
cɛ̀ɛ̀r	cɛ̀ɛ̀r-ɛ̄ɛ̄g	‘singer’	jíil	jííl-īīg	‘locust’
d̪ààr	d̪ààr-ɛ̀ɛ̀g	‘eagle’	ə̀ə̀r	ə̀ə̀r-ììg	‘sheep’
cɔ̄ɔ̄l	cɔ̄ɔ̄l-ɛ̄ɛ̄g	‘donkey’	gùùr	gùùr-īīg	‘stone tool’

(32) Rightward spreading to plural suffix ***-aag***, which changes to ***-əəg*** after [+ATR] roots.

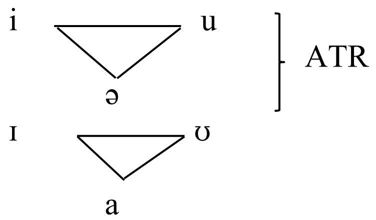
Noun SG	Noun PL				
tɛ́ɛ̀l	tɛ́ɛ̀l-ààg	‘anchor’	îl	íl-ə̀ə̀g	‘horn’
kásán	kásán-áāg	‘friend’	ə̀nd̪ə́ər	ə̀nd̪ə́ər-ə̄ə̄g	‘tree’
bɔ́n	bɔ̀n-āāg	‘heart’	kūūð	kūūð-ə́ə́g	‘shadow’

(33) Leftward spreading from the [+ATR] plural suffix ***–əg,*** whereby [-ATR] vowels in the root change to [+ATR] (Stirtz 2009: 81, 84).

Noun SG	Noun PL	
tɛ̄ɛ̄nd̪	tīīnd̪-ə̄g	‘riddle(s)’
wɛ́ɛ́(s)	wís-sə̄g	‘house(s)’
fānd̪	fə̄nd̪-ə́g	‘cheek(s)’

It should, however, be noted that the alternation between the low mid vowels and the high vowels in Gaam seems to amount to more than just ATR; the low mid vowels also contain the A-element, which must be removed when they become ATR. Alternatively, we could say that the alternation reveals that the mid vowels in Gaam are *phonology* high, i.e. /ɪ/ and /ʊ/ (which that they do not in fact contain the A-element, which would then be added in the phonetic implementation):

(34) double triangular system (Gaam)



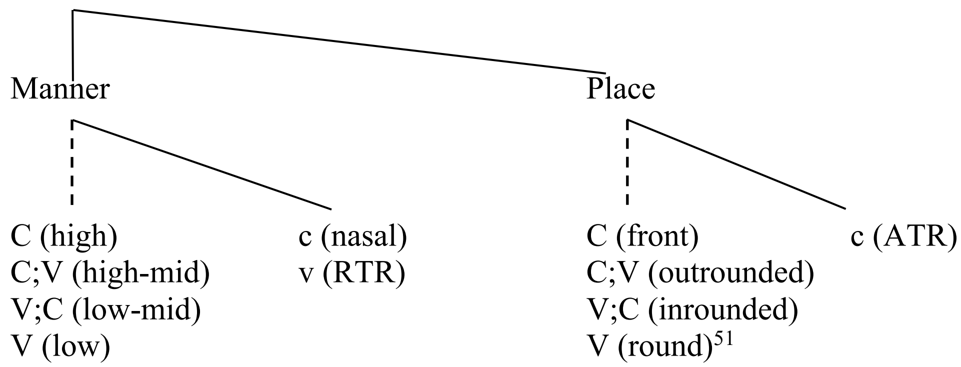
If this is a possible analysis, Gaam would fall under Casali’s Correlation and be predicted to use ATR as the active element.[48]

While, thus, the idea that usage of secondary v or A-headedness for RTR harmony may be dependent on the structure of the vowel system, in the 2020 model, being dissatisfied with the dual phonetic split of secondary v, I adopt (35), which restricts the interpretation of secondary v to pharyngeal *constriction*, RTR. Thisof course raises the question how ATR as an active element is accounted for. To give this element a ‘place’ in the RCVP segmental structure, I returned to an ‘old’ idea that I had proposed in van der Hulst (1988a, 1988b), which was to identify ATR with a dependent usage of the I-element (in the place class). There is good reason to link ATR to the I element, since both draw on activity of the genioglossus muscle which pulls the tongue forward as a consequence of raising and fronting

[48] But perhaps we should not make too much of differences in transcriptions in this case. Various studies of African harmony systems note that the two transcriptions are often both used by different authors for the same languages; see van der Hulst (2018: § 6.3.1.2.1 on Kikuyu).

the tongue body.[49] Also note that the affinity with high vowels, i.e. C manner, is still expressed because the I-element is also a C element (in the place class).[50]With this proposal, we no longer need to say that the secondary manner element v correlates with two opposing phonetic properties. This secondary element always correlates consistently with RTR:

(35) V (rhyme)



The appears to be no secondary version required of the place V element, which is of course slightly unsatisfactory, given the strong insistence in RCVP on structural analogy between the element classes.[52]

A consequence of this proposal (like the one in 27) is that we no longer rule out a language having both pharyngeal harmony and ATR harmony, at least not on formal grounds.

There is, however, a further ambiguity that is noted in van der Hulst (2018). A double triangular system in which the 'lower vowels' are dominant (thus unlike what we find in Gaam) could also be analysed in terms of the primary element V (i.e. as 'A-harmony'), i.e., as a 'lowering' effect.[53]In van der Hulst (2018: 410) I do not offer a solution to avoid this ambiguity and I simply admit that the alternations in Nez Perce can be represented with secondary v or with primary V (=|A|), allowing (29) and (36) as possible analyses:

[49] This affinity is perhaps also the cause of a shift from palatal harmony to ATR harmony which has been said to occur in some Mongolian languages; see Svantesson (1985). Although Ko (2011) argues for the opposite development, this does not take away from the fact that palatal harmony and ATR harmony are closely related.

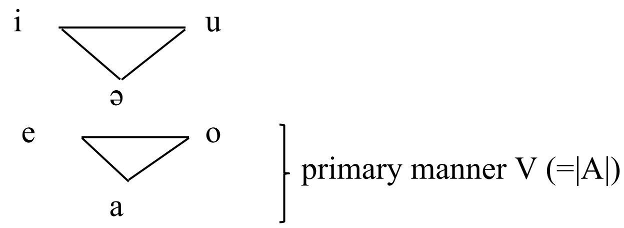
[50] See van der Hulst (2016) for a discussion of the correlations with reference to Wood (1975, 1979, 1982). In Wood's system, his feature [palatal] applies to all high vowels, not just [i]. In the proposal in (33), this would only be the case for the secondary use of the element I ([ATR]).

[51] There appears to be no secondary version required of the place V element, which is of course slightly unsatisfactory, given the strong insistence in RCVP on structural analogy between the element classes.

[52] In VDH20 I analyze 'rhotic(ized)' as a secondary manner property involving a combination of c and v; see (15) where this proposal is incorporated. Interestingly, this property (variously described as 'retroflex' and 'rhotacized') can occur harmonically in a number of languages, such as Yurok, Kalasha and Serrano, although Smith (to appear) regards these as a variety of RTR harmony. A possible avenue to explore would be to analyse the relevant property as secondary v in the place node. Roundness of vowels and retroflexion share an acoustic property that Jakobson and Halle (1956) captured with their feature [flat] which they used for round vowels and for the secondary articulation in consonants including labialization and retroflexion.

[53] I note that this was in fact the proposed analysis in van der Hulst (1988). However, a comparison between the 1988 model and later models is complicated because in the 1988 model there was no distinction between primary and secondary classes.

(36) double triangular system (Nez Perce)



Lowering harmony in term of the A-element is well-motivated. In van der Hulst (2018, chapter 6) I discuss various cases of lowering harmony, mainly in Bantu languages (Hyman (1999), in terms of A-harmony (i.e. with reference to the primary occurrence of this element), which are reported as involving lowering of high vowels /i/ and /u/ to mid vowels /e/ and /o/.

(37) Seven-vowel system with lowering harmony

```
i           u
↓           ↓
e       o
    ɛ       ɔ      } primary manner A
        a
```

In contrast, harmony between the two mid series in seven-vowel systems cannot simply analyzed in terms of the element |A| because both series contain this element to begin with. This is why I have proposed to employ the mechanism of A-*headedness* for such systems, although as we have seen, an analysis in terms of secondary manner v is also possible, but perhaps only chosen in double triangular systems of the Nez Perce type and not available for seven-vowel systems. [54]

We need to ask however, whether the analysis using secondary v in (29) really works for Nez Perce. If secondary manner v represents RTR, then why do high vowels /i/ and /u/ turn into the mid vowels /e/ and /o/, rather than /ɪ/ and /ʊ/? If the dominant non-high vowels are truly mid vowels than the analysis in terms the A-element is more ‘direct’ since it directly captures the difference between the vowels /i/ and /u/ vs. /e/ and /o/.

Given then that RTR is not required for harmony among mid vowels in seven-vowel systems and given that it does not even seem adequate for cases like Nez Perce, it would seem that the move in (35) to reduce the interpretation of the pharyngeal element to RTR was wrong. We only need ATR, which we could then ‘move back’ to the secondary manner class.

However, simply getting rid of RTR causes problems. As usual, making changes in one class typically creates problems elsewhere in the system, which testifies to the fact that ‘everything is connected’ in the RCVP system; there are no local changes without global consequences! Removing RTR creates a problem because we lose the characterization of pharyngealized consonants or pharyngealized vowels as having a secondary manner v, interpreted as pharyngealization; see (14).

For this reason, I feel compelled to stick with (35), which means that we have to live with the fact that secondary manner v, when being harmonic, ‘competes’ with A-headedness

[54] We do not want to say that in such system the high mid vowels are in fact ‘ɪ’ and ‘ʊ’ because that would predict, as per Casali’s Correlation that such a system would have ATR-harmony among the two high series, as in the language Lugbara; see Casali (2003: 326 ff) and van der Hulst (2018: 297 ff.).

harmony (unless we can restrict v-harmony to double triangular systems) as well as with A-harmony (where the account in terms of A-harmony is in fact more accurate. Perhaps then the conclusion should be that secondary manner v represents a 'local property', i.e. pharyngealization of consonants and vowels, but not one that engages in harmonic relations. Or, when it acts non-locally, it involves both consonants and vowels, as in the case of emphatic harmony in varieties of Arabic (Khan, to appear). Interestingly, a similar characteristic is displayed by nasal harmony (Botma, to appear).

Now that I have suggested that secondary manner v plays a rather limited in genuine vowel harmony processes, it is necessary to address a specific argument for allowing both RTR and ATR as active harmonic elements, based on the claim that languages simple have a choice to use either ATR or RTR as the active element for vowel harmony.[55]Opposed to this view, I argue in van de Hulst (2018) that most cases that have been analysed as RTR harmony should in fact be analysed as ATR harmony.

As explained in Lindau (1979), phonetically speaking, a distinction between the relative size of the pharyngeal cavity can be made in three different ways:

(38)		Set 1: larger pharynx:	Set 2: smaller pharynx:
	a.	Advanced = dominant	neutral
	b.	Neutral	retracted = dominant
	c.	Advanced	retracted

This finding has led some phonologists to the conclusion that if (39a) obtains, the active phonological feature is ATR, which is the common choice for African languages. In contrast, if (39b) obtains, the active feature would be RTR. Various authors analysing vowel harmony in Asian languages belonging to the Tungusic and Mongolian language families, have established that a TR distinction is made in terms of tongue retraction, (28b); see van der Hulst (2018: § 9.2.).To support 'RTR' analyses, Li (1996), Zhang (1996), and Ko (2011, 2012) all note that (in the relevant cases) the retracted vowels have generally been described as involving articulatory effort, indicating that the active gesture is tongue root retraction.[56]

In the theory proposed in van der Hulst (2018), while RTR is available as an element (namely secondary manner v), I reject this possibility for the Tungusic and Mongolian languages because this would make the wrong predictions for how neutral vowels behave in harmony systems. I argue at length that the facts regarding the behaviour of neutral vowels in *both* African and Asian languages must lead to the conclusion that the set with the larger cavity (whether positively resulting from advancement of the tongue or negatively resulting from the absence of TR retraction) is the dominant set in all vowel harmony systems that fall under Casali's Correlation, that is, in which there is a TR contrast for high vowels. A comparison between African and Asian languages with TR-harmony in Li (1996: 318 ff) makes clear, the Asian languages that have TR-root harmony do indeed often have two series of high vowels which, as per Casali' Correlation would suggest that ATR is the active element. Given the current proposal, namely to analyse ATR as secondary |I|, all these African and Asian languages that have two series of high vowels must be analysed with harmony in terms of this element. For Tungusic and Mongolian languages in which the non-ATR vowels have active TR retraction, I would argue that this retraction merely enhances the phonetic difference between advanced and non-advanced vowels. Such enhancement might, in fact, also occur in African languages, as shown in Lindau (1975, 1976). In the model proposed here (in 24), the RTR is not even available for the Asian systems, despite the

[55] Since no language seems to use both, this actually supports the idea to see these two phonetic properties as realization of a single element. This was captured in 2018 model.
[56] This is also stated in Ladefoged and Maddieson (1996: 306) with reference to the Tungusic language Even.

phonetic appearance of RTR being active. In conclusion, I suggest that there is no RTR element.

I guess, the reader now realizes the point of this section: the saga never ends…but for this chapter, I *will* end with the following structure:

(39) V (rhyme)

Manner		Place	
C (high) C;V (high-mid) V;C (low-mid) V (low)	c (NAS) v (RTR)	C (front) C;V (outrounded) V;C (inrounded) V (round)	c (ATR) v (Retro)
Raising harmony Lowering harmony Headedness harmony	Emphatic harmony Nasal harmony	Palatal harmony Labial harmony	ATR harmony Retroflex harmony

The two secondary manner c properties in the manner and place class each activate an extra resonating cavity, the nasal cavity the pharyngeal cavity, respectively. Both secondary v elements can occur in harmonic processes of a limited kind (typically involving both consonants and vowels, which suggest that their locality is defined with respect to the segmental ('skeletal') level. We have also noted that raising harmony is limited due to the defectiveness of the C elements in manner (i.e. |∀|), perhaps only occurring under conditions of stress. The odd man out is headedness harmony which captures RTR harmony, not in terms of an active element, but in terms of A-headedness. The suggestion to capture retroflex harmony in term of secondary place v is very tentative.

7 Conclusions

This article summarizes the basic structure of the RCVP model as presented in VDH20 which is the result of considering and rejecting many previous versions. To give the reader a flavor of the struggles that he gone into developing the model, I discuss various alternatives for the representation of contrast that involve activity in the pharyngeal cavity. What emerges from this demonstration is a proposal that is slightly different from the proposal in VDH20, mostly by attributing a reduced role to RTR/pharyngealization in vowel harmony processes, appealing only to A-headedness harmony as a mechanism to express what Casali (2003) and Leitch (1996) refers to as RTR harmony in seven-vowel systems with two series of mid vowels, and to A-harmony in the double triangular cases. Nevertheless, there is a role for secondary manner v in non-local harmony (typically involving both consonants and vowels), comparable to a similar role of secondary c (nasality).

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