Dependency-based Phonologies[1]

(non-final version)

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1. Introduction

This article presents an approach to phonological structure which places head – dependency relations as central organizing relations. This leading idea originates in two models called *dependency phonology* and *government phonology* which today occur in a number of varieties.[2] In this chapter, I present a synthesis of the leading ideas that are shared by all these models, which, for convenience, I subsume under the name *dependency-based phonologies (henceforth, DBP)*. In section 2, I discuss the notion 'head', while section 3 contains some remarks on the organization of the grammar and the place of phonology in it. The use of head-dependent relations in segmental structure and syllabic structure is dealt with in section 4 and section 5, respectively. In this chapter I will not discuss head-dependent relations at higher prosodic levels (such as the foot). In section 6 I discuss the use of so-called empty-head rhymes, which provides the necessary background for a discussion of relations that can be invoked to control the distribution of empty syllabic, and also branching, units which can be interpretation as head-dependency relations of a special kind. In section 8, I briefly discuss some hallmarks of currently prevailing varieties of dependency-based phonological theories. Section 9 offers some concluding remarks.

2. The notion 'head' and related notions

The theories discussed in this chapter all make use of organizing relationships between 'heads' or 'dependents'. The relationship between the head and its dependent is called a head-dependency relation or a relation of government (where the head is said to govern its dependents). Some of these relations define configuration that closely correspond to constituent structures, or indeed they are used to augment constituency relations.

[1] I would like to thank John Anderson, Gienek Cyran, Irina Monich, Nancy Ritter, John Rennison, Tobias Scheer, Peter Szigetvari, Norval Smith as well as the editors of this handbook for very helpful comments on a prefinal draft of this chapter. Needless to say that they do not necessarily agree with all that I say here.

[2] I discuss some important varieties briefly in section 7. See van der Hulst (2006a) and Ritter (2006) for overviews of dependency phonology and government phonology, respectively. Other introductions to government phonology can be found in Harris (1994), Brockhaus (1995), Ritter (1995), Scheer (2004) and to DP in Ewen (1980), Anderson and Ewen (1980), Lass (1984), Anderson and Durand (1986, 1987), Anderson, Ewen and Staun (1985), Ewen (1986), Durand (1990), Ewen (1993) and Anderson (2002). For both government phonology and dependency phonology see Ball (1997) and van der Hulst (in prep a.).

Although dependency approaches to sentence structure have a long tradition (see Fraser 2005), specific dependency formalisms have been developed as alternative to constituency-based grammars (Hays 1964, Robinson 1970), whereas in other cases notions such as 'head' and 'dependent' have been 'added' to the daughter nodes of constituents (Chomsky 1970). In addition, in some of the frameworks discussed here, there are further relations between units that do not necessarily replace or augment constituency, but which are also said to involve a head-dependent relationship. The difference between, what I will call, structural and non-structural relationships can be compared to the difference between relationships between syntactic heads and their modifiers ("complements", "specifiers") and, for example, the relationship between a constituent and an anaphor that this constituent is somehow co-linked with. Indeed, the approaches discussed in this chapter share the assumption (which Anderson 1985, 1992, 2003, 2006 terms *The Structural Analogy Assumption*) that different modules of the grammar employ identical relationships.

In phonology, in (morpho)syntax and in semantics, the terms 'head' and 'dependent' have been used in a variety of approaches and in several works the question is raised as to what a 'head' is (e.g. Zwicky 1985; Corbett, Fraser and McGlashan 1993). It is one thing to define what is understood to be a head within one specific module of the grammar, e.g. in syntax, but if the term 'head' is used in various (or even all) components of grammar, the further question arises as to what extent this cross-modular use of a single term is justified. To find out whether heads in phonology and syntax belong to the same type of entity, or at least are both 'species of one genus', one must not take a specific definition that has been proposed in one domain (e.g. syntax) only to claim that this definition does not fully match entities that are called 'heads' in another domain (e.g. phonology). We need to compare the properties of alleged heads in both (or rather all domains) and focus on the question as to what the true commonalities are. If there are none, it might be advisable to adopt different terms for each domain, which is not the same as saying that any given domain has a natural right to any given term. If there are commonalities, these may need to be stated in general terms that allow the traits found in each specific domain to be regarded as possible instantiations of these terms. In addition, it may be that, due to independent difference between modules, heads (and dependents) have modality-specific connotations. What is said here about the term 'head' applies equally well to terms such as 'government' or 'licensing'.

The most general characteristic of perhaps all uses of the term 'head' (and 'dependent') seems to be that all relationships (whether structural, i.e. between sisters in constituency-based notations, or non-structural) between a unit called 'the head' and a unit called 'the dependent' are *asymmetrical*: [3]

(1) *Asymmetrical*: If A is the head of B, B cannot be the head of A

But that in itself says very little. An additional important aspect of head-dependent relationships is that while a head can stand on its own, dependents presuppose the presence of a head. This is sometimes stated as follows: dependents need to be licensed by a head, while the head needs no licensing. This does not exclude that in specific cases

[3] If A and B are always distinct, the relationship could be called antisymmetrical. However, if, as we will see, a head and dependent can be the same unit, the broader notion of asymmetry is relevant.

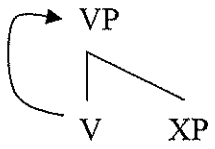
dependents are *required*. This latter situation holds when verbs select a complement, or when vowels (such as lax vowels in Germanic languages) require a following consonant (van der Hulst 1985).

To give more content to notions head and dependent, we need diagnostics that allows us to identify units as either one or the other. I will single out two such diagnostics: visibility and complexity. In comparison to dependents, heads are 'more visible' and '(often) more complex'. These diagnostics are relevant in both syntax and phonology which, in my view, supports the idea that there is a notion of 'head' (and 'dependent') that generalizes over these two domains in a meaningful way.

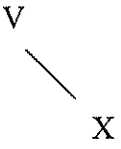
A specific diagnostic of head can be called *visibility*. Formally, in constituency-based syntax, features of heads are projected to the mother node of a constituent. Neeleman and van der Koot (2006) claim that projection does not exist in phonology, which forms one reason for their claim that syntax and phonology employ different kinds of representations. But if vowel harmony is construed as a relation between syllables (or perhaps rhymes), the featural properties of their head vowels *must* be visible in the syllable (or rhyme) node. By assuming that syllables (or rhymes) are headed by their vowels and projection takes place, vowel harmony can be construed as a local relation between syllable (or rhyme) nodes, as suggested in van der Hulst and van de Weijer (1995).

The relevance of the formal notion of 'projection' is dependent on a particular way of representing relationship, namely in the form of constituency (viz. 2a). If a direct dependency presentation as in (2b) is adopted, it follows necessarily that the head properties are the ones that count at higher levels of organization, simply because the head *is* the node that characterizes the whole constituent:

(2) a.

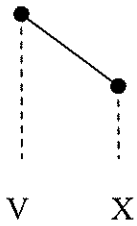


b.



The dependency notation in (2b) is a notational variant of another notation for dependency trees (cf. Anderson and Ewen 1987):

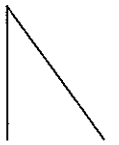
(3)



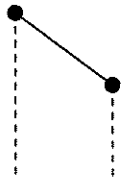
If anything along the lines in (2) and (3) is an adequate way of representing syntactic structure, then, given the analogies between syntactic structure and phonological structure

that has just been mentioned, there is no reason to reject a representation of rhymes in terms of, for example, (4):[4]

(4) a. NucleusP (= Rhyme) b.



Nucleus Coda



Nucleus Coda

All these notations are means to express headedness *and* linear precedence, the latter in terms of the linear precedence in a two-dimensional plane, which represents a linear precedence between the units that enter into the dependency relation. If linear precedence is not relevant (either not at all, or not at the relevant level of representation), no slanted (constituent and/or dependency) lines are necessary and notations such as the following can be used:

(5) a. (Nucleus) b. Nucleus

(Coda)

Coda

Such representations (which are perfectly fine in strict dependency notations) can be used if the linearization of nucleus and coda can be attributed to a different subcomponent of the grammar (see Anderson 1986). Notations of this kind are, in fact, common with reference to segment-*internal* structure in models in which head-dependent relations are postulated between the ('co-temporal') features that make up phonological segments. Dependency phonology, indeed, uses dependency relations between monovalent features (here called *elements*).

(6) a. |A| b. |I|

|I| |A|

[ɛ] [e]

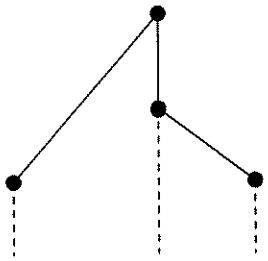
(|A| represents 'lowness' while |I| represents 'high-frontness')

I will discuss segment-internal structure in more detail in section 4.

[4] Levin (1985) indeed proposed a theory of syllable structure which suggests a structural analogy between syllables and syntactic phrases as headed constituents. The parallelism between syllables and syntactic phrases is, however, an older observation; cf. Pittman (1948), Pike (1943).

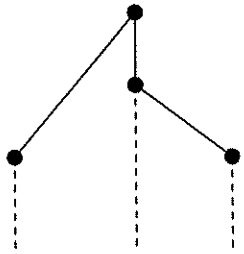
Returning to syllable structure, there can be (and often has been) noted a further analogy between the relations between sentences and syllables, which allows us to highlight a specific type of dependency:

(7) a.



NP V XP

b.



Onset Nucleus Coda

Note here that the heads (i.e. V and Nucleus) are represented as heads *of themselves* in order to capture, in a dependency notation, that the relation between heads and following material is more intimate than between head and preceding material (cf. Anderson and Ewen 1987). The dependency graphs in (7) 'reconstructs' the NP – VP division and the onset – rhyme division, respectively.

The structural analogies between sentence structure and syllable structure are 'striking' and it would therefore be counterproductive to approach both types of linguistic units in different structural terms. Indeed, John Anderson has claimed that dependency trees (and thus head-dependent relations) are adequate notational devices both in phonology and in morphosyntax. This point is, of course, independent of the kind of grammar formalism that is adopted in both domains and it holds equally well in case one uses constituency-based formalisms. More than any other phonological model, Dependency Phonology has been founded on the premises that dependency (and thus headedness) is a foundational (and sufficient) concept in phonology and indeed in grammar at large.

In any event, whatever formalism is used, heads have a greater visibility than dependents, which is either expressed by appealing to projection or, more directly, by having heads dominate their dependents. Even in the representations in (6) visibility is a diagnostic of heads in that the structure in, (6a) is meant to be acknowledged in the phonology as a |A| type of vowel, that is forming a natural class with other |A|-headed vowels, whereas the structure in (6b) represents a |I|-type vowel.

Returning to the analogy between syntax and phonology, and addressing the claim in Neeleman and van der Koot that these domains appeal to fundamentally different kinds of structure, Dresher and van der Hulst (1998) have noted that dependency relations, especially at higher phonological levels (i.e. above the syllable) indeed appear to be of a different kind than the relations discussed so far. Whereas the relationships discussed so far (for phrase structure in syntax and for syllable structure in phonology) hold between units *of different kinds*, namely atomic units (such as 'N', or 'V') and units that themselves (can) have an internal head-dependency structure (i.e. phrases),[5] relationships

[5] By analogy, in syllable structure, the nucleus is atomic (it contains a vowel), while onsets and codas are potentially complex. It might be countered that the nucleus can contain a long vowel or diphthong and if we wish to maintain that nuclei are atomic this would mean that such entities are complex intrasegmentally, or

within the (metrical) foot hold between syllables, i.e. entities of the same kind. Dresher and van der Hulst call these two kinds of relationships α-β and α-α relations, respectively. The latter kind of relations may be unique to phonology, having no counterpart in morphosyntax, although this, as always, depends on one's analysis of phenomena such as conjunction or, more specifically, compounding. Additionally, intrasegmental relations (between features or elements) are of the α-α type, but this may equally be true for the features that make up syntactic categories.

However, whatever the reason may be for a modularity difference between phonology (allowing α-α relations at higher levels) and morphosyntax (not allowing α-α relations), this difference is irrelevant to the general claim (central to the dependency approach) that *all* relationships are headed. And, indeed, in all strands of metrical/prosodic phonology, as well as in dependency phonology, it has been assumed that higher levels of organization are headed. This brings us to a second diagnostic trait of heads and dependents, namely (relative) complexity.

Dresher and van der Hulst (1999) show that phonological heads in α-α relations display a systematic head-dependent asymmetry in terms of their relative complexity which is subject to the following constraint:

(8) The Complexity Constraint
Dependents cannot be more complex than heads

This constraint captures a complexity asymmetry between heads and dependents. In fact, while, in the limiting case, heads and dependent can be of equal complexity, it is more typical for heads to allow a greater array of structures than dependents. This asymmetry can take three different forms. Given that all possible units that can be head or dependent at some level can be ranked on a scale of increasing complexity, the sets of units that can be heads or dependents can (a) be complementary, (b) intersecting or (c) stand in a set-subset relation (always with dependents taking the lower portion of the scale, and head the higher portion). In the latter case, which is the more typical one, heads, allow all the structures that dependents allow, and in addition allow more complex structures. This greater potential for complexity corresponds to a greater array of phonotactic possibilities. For example, stressed syllables often allow greater complexity in their vowel structures, which results in the fact that the set of vowels occurring in dependent syllables is a subset of the vowels that occur in the head. Case (a) or (b) arises, when heads may require a degree of complexity which is not required for dependents. This underlies the distribution of schwa-vowels in English which are considered too simplex (namely contentless) to occur in stressed syllables.[6] In this case the vowel inventories of

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that they form two nuclei. These issues cannot be discussed here. Also, in government phonology it is claimed that codas are always simplex.

[6] With reference to onsets, the following head-dependent asymmetry may be noted: dependent syllables must have an onset, while head syllable do not need to. Thus head syllables allow a greater array of options, if the relevant criterion was structural complexity, one would expect perhaps that dependent syllable would only allow onsetless syllables. This suggests that the notion 'complex' should be replaced by a more abstract notion 'marked'. Less complex entities such as empty nuclei (schwa) and onsetless syllables (i.e. empty onsets) are more marked, because, like complex entities, they deviate from the unmarked norm which is '1' , i.e. one element to characterize a nucleus, or one segment to characterize a syllabic constituent.

stress and unstressed syllables reflect case (a) because unstressed vowels allow only schwa, whereas stressed syllables allow all vowels, but schwa. A more intricate situation exist in Brazilian Portuguese which allows all vowels in primary stressed syllables, a subset in pretonic unstressed syllables and an even smaller set of three vowels in post-tonic unstressed syllables (Cristófaro-Silva 1992).

Asymmetries of this kind imply that the parametric settings for vowel inventories or syllabic inventories are relative to head and dependent positions of the relevant units, which underlies the relevance of the head-dependent distinction for parameter setting (cf. van der Hulst and Ritter 2002).

Dresher and van der Hulst (1999) point out that we also find the notion of projection at higher levels of prosodic organization. Due to their visibility certain conditions can be imposed on heads, which cannot be imposed on dependents because the internal structure of the latter is not visible. This leads to circumstances which are apparently at odds with the principle in (8). If, for example, a condition is that a unit may be at most binary branching, dependents may get away with being more complex, simply because their internal structure cannot be seen, while heads must adhere to this requirement. I refer to Dresher and van der Hulst (1999) for examples of this phenomenon.

The above supports the claim that head-dependency relations are just as relevant in phonology as they are in syntax and that, moreover, heads in both domains are species of a common genus. Projection or visibility and complexity can both be understood as consequences of, what I take to be, the fundamental idea behind headedness which is this: if in a combination [AB], B is the head, we mean to say that the combination as a whole is 'a kind of B'; [AB] is a subclass of [B]. From this it seems to naturally follow that [B] (in the combination [AB]) is the central unit and that most of the properties of [AB] come from [B], with [A] contributing only some or even none of its properties. This accounts for projection or visibility.

In specific modules heads have been said to have another diagnostic, namely perceptual saliency. Intrasegmentally, head elements are perceptually more salient than dependent elements. Syllable nuclei have been called the head of the syllable because they have the highest degree of sonority which makes them more salient. Thirdly, stressed syllables are heads of feet and they are also more perceptually salient than dependent (unstressed) syllables. Perceptual saliency, however, can easily be construed as a natural consequence of what it means to be a head because heads are more visible to the phonetic implementations and thus more salient. Centrality and visibility, in fact, also explain higher relative complexity because it seems natural that the more central the unit is, the more important this locus is for creating a greater array of contrasting options.

In this section I have used the terms 'head' and 'dependency', as they are used in dependency phonology. The term 'government' (which underlies the name of the model called 'government phonology') is simply the inverse of dependency. Thus, a head can be said to govern its dependent. Another term, 'licensing', is often used interchangeably with 'government'. Since a dependent cannot exist without a head, it can be said that a head 'licenses' its dependent(s). In section 6, I suggest to use 'government' for structural head-dependency relations and 'licensing' for non-structural (also called 'lateral') relations.

3. Phonotactic structure, constraints and the organization of grammar

As all other phonological models, dependency-based phonology (DBP) aims at characterizing properties and computations that pertain to the phonological properties of grammatical expressions, i.e. simplex units (i.e. morphemes), as well as morphological and syntactic constructions. Specifically, there is a set of elements[7], partly related in terms of headed relations (cf. 6), which are associated to segmental root nodes, which in turn associate (perhaps via so-called *skeletal positions*[8]) to syllabic nodes, namely *onsets* and *rhymes* which also display head-dependent relations internally. Additionally, between the onset and rhyme nodes there are headed relations (here called *syntagmatic licensing constraints*) which control the distribution of branching or empty occurrences of these two units, i.e. those types of syllabic units that contribute to the complexity of phonological representations (i.e. deviations from the unmarked CVCV… sequence):

(9)

Onset and rhyme nodes
:
(Skeletal positions)
:
Root nodes
:
Elements

The combined linkage of elements to a single segmental root node is subject to *co-occurrence constraints*. Likewise, there are *structural constraints* on the number of root nodes or skeletal positions per syllabic unit as well as constraints on the elemental content of these nodes (*paradigmatic* or *positional content constraints*). Additionally, there are *syntagmatic* or *sequential content* constraints that control the content of root nodes with reference to each other (such as vowel harmony).

(10) Typology of Phonotactic Constraints

a. Complexity of syllabic constituents (section 3)
   i. Onset obligatory (yes/no)
   ii. Branching (yes/no)
   iii. Empty-headed (yes/no)

b. Licensing of marked syllabic constituents (section 6)

c. Element co-occurrence constraints

d. Positional content constraints

[7] In dependency phonology and government phonology primes are single-valued (monovalent, unary) entities, referred to a *components* and *elements*, respectively. Here I use the latter term.

[8] The need of both root nodes and skeletal position is debatable. cf. Selkirk (1990) and section 5.

e. Sequential content constraints[9]

A *phonotactic representation* is only one dimension of a linguistic expression, i.e. an expression generated/admitted by the mental grammar of a speaker/listener, the other dimensions (minimally) being, a *semantic representation*, and mediating between these two, a *morpho(syn)tactic representation*. A *morphotactic* representation results from combining or 'merging' (in terms of constituency and/or dependency relations) linguistic units (morphemes, words, phrases) into larger units in accordance with a set of *morphotactic constraints* which guarantee wellformedness. Each such product then needs to also be examined by the grammar for its phonotactic and semantic wellformedness, a 'procedure' formerly called 'interpretation'. We can see this procedure as involving *checking* whether (morphotactically wellformed) merge products are also wellformed phonotactically and semantically. If this is not the case, and here I will only be concerned with the phonotactic side, an expression is illformed. Since phonotactic requirements and semantic requirements are fundamentally different in nature it is to be expected that many attempts to merge units will meet the constraints imposed by both subcomponents of the grammar and for that reason, presumably, mental grammars provide computational mechanisms to 'repair' at least some of the phonotactic representations that are delivered by the merge procedure, namely those that turn out to be illformed phonotactically. Different models have somewhat different ways of implementing the need for repair rules. As in standard generative phonology (Chomsky and Halle 1968), Dependency Phonology adopts 'phonological rules' that perform repair operations, being agnostic on the need for extrinsic ordering between these rules.[10] Government Phonology builds repair into, what is called, phonetic interpretation.

4. Intrasegmental dependency

Both dependency phonology and government phonology make use of asymmetrical relations between elements that form the content of skeletal positions. In the former model this relation is said to be a head-dependency relation, whereas the latter model avoids this terminology, seeing the 'dependent' elements as an 'operator' (cf. Kaye, Lowenstamm and Vergnaud 1985). In this section I discuss the motivation for using intrasegmental dependency in combination with monovalent elements.

Dependency Phonology did more than introduce the concept of dependency in phonology. A second hallmark of this model was the consistent use of *monovalent* (*unary, single-valued, privative*) *primes*, thus rejecting the binary features stemming from Jakobson, Fant and Halle (1952) and Chomsky and Halle (1968). From the outset it is crucial to emphasize that the use of monovalent primes does not break with the idea that (minimal) contrast is a foundational notion in phonology. Logically, a minimal contrast

[9] In this chapter, I do not discuss constraints of the type c, d and e, although specifically the latter (the sequential content constraints) too can be construed as non-structural, lateral head-dependent relationships, whereas referents to head or dependent status places a role in c and d.

[10] As is well-known this need depends on the abstractness of underlying forms. In general, the practice in Dependency Phonology has been to not embrace the excessive abstractness of standard generative phonology.

between two segments can be expressed in the following two ways (not considering other possibilities):

(11)	a.	/p/	/b/	b.	/p/	/b/
		[-voice]	[+voice]			[voice]

Generative phonology started out with (11a) and then developed 'markedness theory' and subsequently (radical) underspecification theory (Kiparsky 1982, Archangeli 1984; Archangeli and Pulleyblank 1994) in order to be able to express an apparent asymmetry between the two values of almost all features. In the extreme case, one of the values is completely 'inert', i.e. entirely invisible to the phonology. This can be accounted for by adopting the mechanism of underspecification (which had originally been expressed to capture redundancy). But, as Steriade (1995), which offers a general discussion of these issues, points out, a more radical approach is to simply deny the invisible value any theoretical status. However, rather than proceeding by 'cautiously' turning binary feature into unary feature one by one (as suggested by Steriade), a methodologically more adequate approach is to start out on the assumption that all features are monovalent (Kaye 1988), for the reason that this 'bold' step can be falsified, whereas the cautious approach cannot. Dependency Phonology took the bold approach in the early seventies and, following this lead, so did Government Phonology and also Particle Phonology (Schane 1984, 1995).[11] To date, the viability of this bold hypothesis, is still being tested. One potential problem in falsifying the strong monovalent hypothesis is that an apparent counterexample, which, say, seems to require reference to both 'values' of a traditional binary feature, could be immunized by proposing that there are two monovalent primes which come close to being each others opposite (cf. Steriade 1995). However, a difference would still exist between [+F] and [-F] and [F]/[G] (G characterizing the same natural class as [-F]) if the latter approach makes crucial use of allowing both [F] and [G] to be part of a single segment which could not be mimicked by the binary system (if we disallow intrasegmental sequentiality). This (i.e. the idea of combining monovalent elements, even when they would appear to have antagonistic interpretations) is precisely what we see in the dependency-models.

In this chapter I will not review any specific proposals for inventories of phonological elements.[12] Rather I will focus on the use of dependency relations in intrasegmental structure, using the three vowel elements that were originally proposed in dependency phonology (Anderson and Jones 1974, Anderson and Ewen 1987: 206; Ewen 1995):

(12)	|A|	'lowness'
	|U|	'roundness'

[11] Another early proponents of 'simplex' features is Sanders (1972).

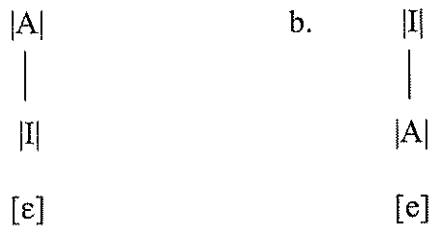
[12] It is interesting that Dependency Phonology (in a specific development called 'Radical CV Phonology'; van der Hulst 2005a) and developments in Government Phonology (e.g. Ritter 1997, Kaye 2000) have converged on the hypothesis that no more than six monovalent primes are necessary to account for all contrasts and 'processes' in all the world's languages. For general motivations for unary elements see Anderson and Ewen (1987), van der Hulst (1989), Harris and Lindsey (1995).

|i| 'frontness'

In (12) I have provided articulatory glosses for the elements. Both Dependency Phonology and Government Phonology specifically state that the elements are to be understood as primarily acoustic in nature (in agreement with Jakobson, Fant and Halle 1952), i.e. mental acoustic images (Harris and Lindsey 1995, Ingleby and Brockhaus 2002). However, it seems inevitable to assume that acoustic images must be linked to articulatory motor programs, and vice versa. After all, in production acoustic images need to be realized, while, in perception, they also need to be identified in order to trigger the motor program. Thus, it would seem inevitable that, for each element, we need to know both the acoustic targets and the articulatory plans, neither of which can be completely invariant given that, as we will see, each element corresponds to a variety of implementations which depend on its status as head or dependent.

Intrasegmental dependency relations are used to differentiate, for example, differences in vowel height, as already shown in (6), repeated here for convenience:

(13)



(|A| represents 'lowness' while |I| represents 'high-frontness')

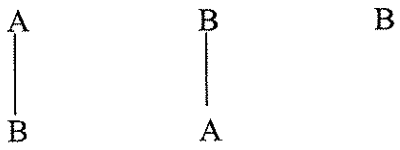
In the representation in (13a) the element |A| is a head which accounts for its greater salience, i.e. its greater contribution to the overall phonetic quality of the vowel, whereas in (13b), the element |I| is more prominent. In terms of projection or visibility, representation such as in (13) embody the idea that an |A|-headed vowel structure behaves as a low vowel, that is, on a par with other |A|-headed vowels, including the vowel /a/ which only possesses the element |A|. Conversely, the element |I| in (13a), being a dependent and thus 'invisible', could not be used to group the relevant vowel with other, |I|-headed structures. In other words, intrasegmentally, visibility and salience are properties of intrasegmental heads, as they are of heads in higher levels of organization. Whether intrasegmentally, heads can also be more complex (i.e. be itself a compound of more than one element) than dependents (which, then, would have to be at most a single element) is an issue that I will not discuss in this chapter.

In general, there are six advantages of a dependency-based monovalent approach which remain valid even if the details of the structures or their interpretations are modified.[13]

Firstly, by invoking dependency relations, we can strike a balance between systems of phonological primes that allow (in principle unrestricted) use of multi-valued features and 'Jakobsonian' systems that only allow binary oppositions. For any given pair of elements, there are four possible configurations:

[13] An additional argument is provided in section 4.3.

(14)



The relations in (14) allow a relative (yet restricted) expression of the prominence of any given element and thus the expression of stepwise, quasi-scalar processes, a point that Anderson and Ewen (1987) underscore with reference to accounting for synchronic reflexes of lenition and fortition processes. In fact, we give expression to all three kinds of oppositions as originally recognized by Trubetzkoy (1939). Privative oppositions involve the presence versus absence of a prime. Equipollent oppositions involve the presence of a prime in one member of the opposition and the presence of another prime in the other member of the opposition and, thirdly, as already mentioned, gradual, multivalued oppositions can be expressed in terms of the way in which a particular component enters in the composition of a class of segments (i.e. as head or dependent).

Secondly, by replacing binary features with constellations of unary elements, varying in complexity, representations adequately reflect the relative markedness of phonological segments and their properties. In (14), the simple structures (consisting of only one element) are less marked than the categories that are represented in terms of element combinations. Binary notations can only capture such distinctions by augmenting the basic apparatus with an ad hoc system of underspecification.

Thirdly, if we assume (as most phonologists do) that phonological rules can only reflect phonetic events by manipulating phonological units, the set of element in (12) expresses the claim that languages can have roundness spreading (as an assimilatory process) but not the spreading of non-roundness. If this is empirically correct, the theory in (15) is superior to binary feature systems in which [+round] and [-round] have the same status and are both available for phonological manipulation.

Fourthly, given the addition of a head – dependent relation, an impressive reduction in the number of primes can be achieved. In order to characterize major classes and manner distinctions in the feature system of Chomsky and Halle (1968) (or its feature geometric descendants) one needs many features (such as [voice], [nasal], [lateral], [strident], [continuant], and so on) where unary models use just two single-valued primes, the components |C| and |V| and their interdependencies.

Fifthly, the dependency-constellations are constructed in such a way that often-observed affinities between the phonological categories that they represent are formally expressed. For example, one and the same element |L| is used to express voicing and low tone and whether one or the other interpretation is relevant is dependent on the head or dependent status of the element. This makes immediate sense of the often observed connection between these two different phonetic properties belong to obstruents and vowels, respectively.

To illustrate the two latter points consider the proposal in van der Hulst (1988a, 1988b) to adopt the following interpretations of the three elements in (12) as either heads or dependents:

(15) Head Dependent

|A|	'lowness'	'retracted tongue root'
|U|	'backness'	'roundness'
|I|	'frontness'	'ATR'

This proposal makes explicit that the phonetic interpretations of elements can differ depending on their status as heads of dependents. My goal is not here to discuss the merits of drawbacks of the specific interpretations, but merely to illustrate how the use of dependency can make it possible to account for the relatedness of certain sets of phonetic properties (which are denoted by separate features in other framework) by postulated a single element for them. The proposal in (15) has been extended to all elements in the dependency model called Radical CV Phonology (van der Hulst 2005a).

Sixthly, it has been argued recently (for example in Clements 2002) that phonological representations should be specified minimally, i.e. with only those feature specifications that are needed in the phonology. Representational minimalism has been a core result of monovalent systems since the inception of Dependency Phonology and Government Phonology. The use of monovalent primes largely undercuts discussions about leaving or not leaving out redundant specifications and further contribute to what I earlier called a 'minimal phonology'.

Finally, let us briefly compare the use of dependency relations discussed here to usage of this notion in other segment models. In models of feature geometry (as summarized in McCarthy 1988), dependency refers to the fact that certain features are subordinate to other features to indicate that the former are only relevant within the 'domain' of the latter. For example, [lateral] is subordinate to the feature [coronal] to express that only coronals can be distinctive specified for laterality. Another use of dependency is proposed in Mester (1988), who proposes that a dependency of one feature on another feature accounts for the fact that the former, dependent feature 'gets a free ride' on a process or generalization that is formulated to apply to the dominating feature. Both uses of dependency seem rather different from the use of dependency in Dependency and Government Phonology but I refer to Ewen (1995) for a more detailed comparison.

5. Intrasyllabic dependencies

In section 2.2. I already, briefly, discussed head-dependency relations at the syllabic level. In this section, I will review the head-dependency structure of segments into syllabic units, and between these units, in more detail.

DBP takes the central units of phonotactic representations to be the *Onset* (O) and *Rhyme* (R). In government phonology it is stated that a regular alternation of O and R is axiomatic (Kaye, Lowenstam and Vergnaud 1990, Kaye 2000). A language that seems to allow syllables without onsets is, in this view, allowed to have Os without segmental content. It *is* possible to defend a different view (following, in this respect Dependency Phonology and other OR models) in that we allow a language to have O as an option. Although there is not much difference between these two views (Os can be absent/Os can lack a skeletal point), henceforth I will assume that each R *is* preceded by an O. In section 6 I will argue that there is an advantage to this view.

I will now first discuss the use of dependency relations at the syllabic level in Government Phonology and then turn to their use in Dependency Phonology. As we will see, while the former model is based on the notion of constituent structure, the latter is not.

Government Phonology[14] (Kaye, Lowenstamm and Vergnaud 1990) assumes that, depending on a parametric choice, both O and R can branch in a given language (i.e. dominate two skeletal points), or can be 'empty-headed' which means that there is only one skeletal point which, however, has no content:[15]

(16) Basic principles and parameters of Government Phonology

Principles:

a. A phonological representation is a linear arrangement of alternating O(nset) and R(hyme) nodes

b. Each R universally dominates at least one X-position (i.e. the syllable head)

Parameters:

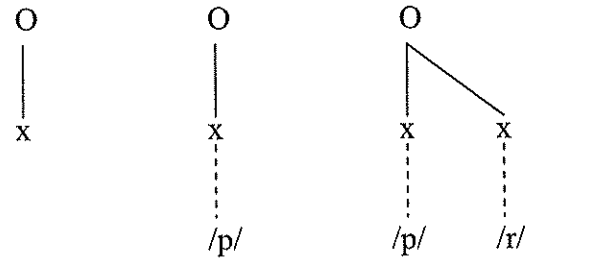
c. Each O dominates at least one X-position ('onset is obligatory')

d. Each O and R may be maximally binary branching.

e. The head of an O or R may be empty

These five basic principles allow the following six representations:

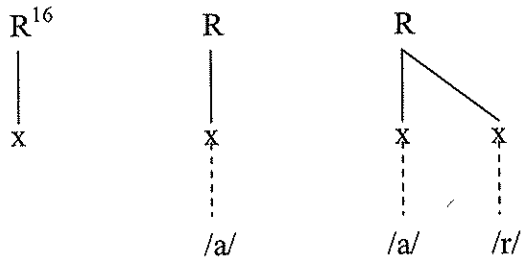
(17) Possible syllabic constituents



"edge" "bridge"

[14] The idea that syllabic constituents can branch is abandoned in the so-called 'strict CV' version of Government Phonology (Lowenstamm 1996, 1999; Scheer 2004); see section 7.

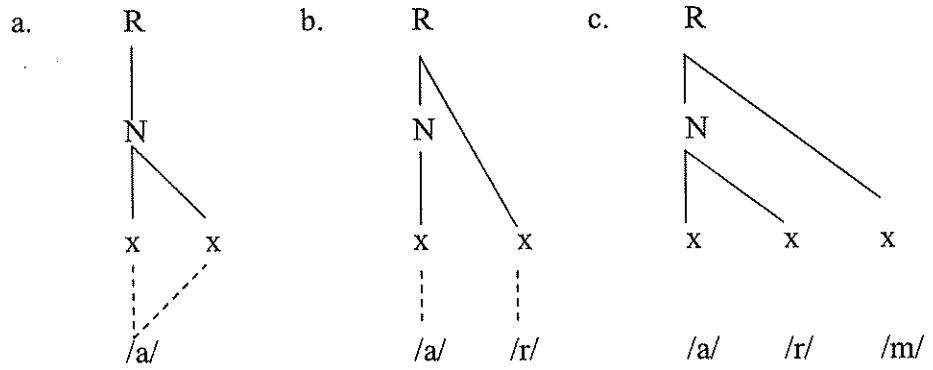
[15] Below, we will consider whether such empty-headed constituents can be branching, i.e. have a contentful dependent. Also note that Government Phonology assumes a 'nucleus node' which is dominated by the rhyme node. I dismiss that option and discuss the issue below. Finally, being constituent based Government Phonology uses skeletal points which, simply, are the terminal nodes of the syllabic constituents.



Here the terms "nucleus" and "coda" are informal labels for the Rhyme head and Rhyme dependent position. It is convenient to have an analogous term pair for both onset positions and I propose to use "edge" and "bridge", respectively.

Government Phonology has adopted the idea that all constituent structure is strictly binary: a mother node can have at most two daughters. This stipulation (which has also been put forward in the domain of syntax, e.g. Kayne 1994). Taking this one step further, it has been claimed that onsets and rhymes cannot contain more than two segments. This view excludes treating the sequence /arm/) as a single rhyme.[17] Seemingly in conflict with the latter claim, Government Phonology (as in Kaye, Lowenstamm and Verngaud 1990), does make a distinction between Nucleus (18a) and Rhyme (18b) as potential branching constituents:

(18)



However, because it is claimed that ternary rhymes (resulting from combining the branching option in both structures) should be ruled out, an extra principle is stated to the effect that the skeletal point of dependents must be strictly adjacent to that of their heads. In the case of a ternary rhyme (e.g. *arm* in *warm*), this constraint is violated because /m/ is not adjacent to /a/ in the relevant sense. Van der Hulst and Ritter (1999a), however, suggest to simply deny the distinction between nucleus and rhyme and thus stick to the six representations in (12). In the discussion in section 7, I will follow this suggestion.

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[16] Not allowing a distinction between a pointless and a pointed empty constituent would allow the use of bare O and bare R for empty-headed, i.e. contentless constituents, but nothing, except the saving of ink, depends on that difference.

[17] A string of any length can be represented in terms of an *unbounded* binary branching structure. Hence the strict claim that Government Phonology makes should be stated such that it allows only *bounded* (in the sense of non-recursive) constituents. Kaye (1990a) states this by requiring that a head c-commands all its dependents.

While branching constituents have traditionally been postulated for, for example, prevocalic consonantal sequence of rising sonority (usually taken to form branching onsets), or vowel consonant sequences said to form closed syllables (usually taken to form branching rhymes), a word or two needs to be said about empty-headed constituents which I will discuss more thoroughly in section 5. Briefly, these contentless, yet present constituents are motivated by cases where an apparent onsetless syllable behaves *as if* it starts with a consonant, or where an apparent non-existing rhyme shows up as a full vowel in related forms. An example of onsetless syllables that behave like syllable starting with a consonant as the so-called h-aspiré words in French. These words (such as *hache* [aʃ] 'axe') select the definite article *le* which otherwise only occurs before words that start with a consonant, e.g. *le chat* 'the cat', while words starting with a vowel take l', e.g. *l'ami* 'the friend').

A crucial aspect of the above representations is that syllabic constituents are *headed*, the head being graphically indicated by the vertical line.[18] In onsets the least sonorous segment (typically or perhaps exclusively an obstruent) is the head, whereas in the rhyme the most sonorous segment claims this privileged status.

The idea to represent onsets and rhymes as (left-)headed units accounts for the fact that the left-hand member in a complex syllabic unit is the most salient segment *in that unit*. Thus, complex onsets like /pl/, the /p/ is the optimal (i.e. *least* sonorant), whereas in a complex rhyme /am/, the vowel /a/ is the optimal (i.e. *most* sonorant) unit. The visibility of heads is evident from the fact that processes referring to syllabic units can see their heads, but no, specifically, their dependents. The visibility of rhymal heads, as already mentioned, is evident from vowel harmony processes. The visibility of onset heads can be inferred from reduplication processes which reduplicated /pl/ as /p/, rather than as /l/ (cf. Steriade 1988).

The issue of complexity is relevant within syllabic constituents if relationships between segments are analyzed as α-α relations. It can easily be seen that heads have a greater array of choices than dependents in complex onsets. For starters, singleton onsets can generally be any consonant, while dependents (as is claimed in Government Phonology) can only be sonorants (cf. below). However, in complex onsets, we note that heads are also limited, in the sense that only obstruents can now be found in this position.[19] Nonetheless, heads allow greater complexity in that onset heads typically have an array of place and laryngeal options which are not available for sonorants in dependents positions.

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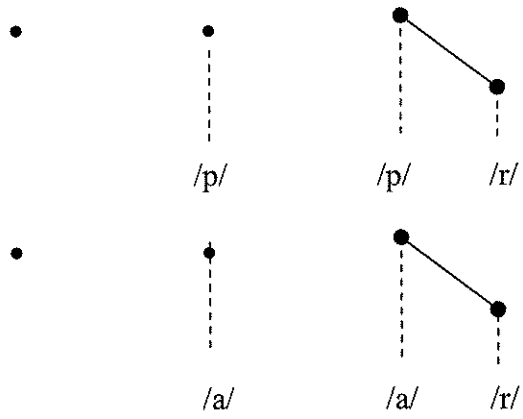
[18] Initially, Dependency Phonologists designated the sonorant consonant to be the head of a branching onset, claiming that in both onsets and rhyme maximal sonority determines headhood. In Anderson (1986) it is suggested that obstruents are heads of onsets so that now the generalization is that in both syllabic constituents the most typical or optimal and most preferred segment type is the head. This view, which was also adopted in Government Phonology (but not in Scheer 2004), is more appropriate in that, in general, the head determines the 'nature' of the constituent of which it is the head. This being said, it must be allowed that in non-branching onsets or rhymes non-optimal segments (such as sonorant consonants) can be heads as well; I return to this issue below.

[19] This kind of 'polarization' can be seen as a specific instantiation of the head-dependent asymmetry principle in that in head-dependent combinations, heads 'retreat' to the optimal choices, to enhance the contrast with their dependents. We also see this in stress feet when head syllables bar schwa-vowels which are precisely the vowels that occur in dependent syllables (as in English).

In addition to making strong claims about the structural complexity of syllabic constituents, Government Phonology has also adopted strong restrictions on the kinds of segments that may occur in, especially, branching constituents. With reference to onsets, for example, (but this has been generalized to all head-dependency relations that holds between segments, also the lateral ones) it has been claimed that dependents cannot be more complex than heads (see especially, Harris 1994: 170-178). Since, in onsets, obstruents can combine with sonorants (as the only option allowed), it follows that, intrasegmentally, obstruents are more complex (in terms of their elemental make-up) than sonorants. Note, that this 'complexity condition' was already introduced in section 2 and what we see here is that, in this government phonology claim, complexity plays the role that we expect, thus confirming that relative complexity is indeed a general trait of heads versus dependents.

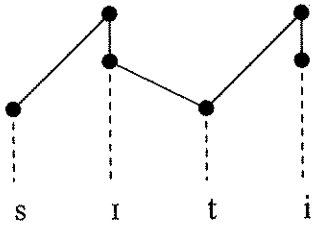
Government Phonology shares with Dependency Phonology a crucial reliance on head-dependency relations. At the same time Anderson and Ewen (1987) suggest that it may be the case that linguistic structures such as those encountered in phonology adhere to strict binarity, thus disfavoring or even disallowing multiple dependents on one head. Nonetheless, Dependency Phonology is not constituent-based. It appeals only to dependency relations as organizing relations. Corresponding to the representations in (17), we would have the following structures, although it must be added that the left-most representation which exclusively consist of a node are not found in the dependency model which takes syllabic nodes to be strictly projections from segmental nodes:

(19) Possible syllabic constituents



A head-dependent approach does not exclude the possibility that one head could have more than one dependent (although this potential limitation is assumed in Dependency Phonology) nor, in fact that one dependent has more than one head, although it is clear that the latter option, if allowed, leads to an important difference between dependency graphs and constituency graphs. Dependency Phonology has proposed to use 'improper bracketing' for the representation of so-called *ambisyllabic consonants* (often suggested for single consonants following lax vowels in Germanic languages):

(20)



This article is not the place to argue in favor of either constituency-augment with dependency labeling or strict dependency models (see Fraser 2005). Needless to say that the burden of proof lies with proponents of constituency-based models which are more complex structure than pure dependency structures.

6. Empty-headed constituents and lateral head-dependent relations

Government Phonology, as we have seen, allows the use of constituent whose head position has no segmental content (so-called empty-headed constituents). Let us first establish that empty-headed Os (or floating empty skeletal positions[20]) have been proposed in a variety of cases and different models where a vowel initial unit can behave as if it starts with a consonant (French *h-aspiré*; Turkish /ɣ/; Clements and Keyser 1983; Denwood 2006, Charette 2004), or in which such units trigger gemination of a preceding consonant (Lowenstamm 1999). Empty-headed rhymes are less familiar objects, although they also have been suggested in other frameworks than Government Phonology (Anderson 1982, Shaw 1993, Nepveu 1994, Oostendorp 1995). The innovation of Government Phonology, however, was to introduce systematic constraints on the distribution of empty-headed rhymes (EHR).[21]

There are two partly independent reasons for introducing EHRs in phonological representations, namely to account for vowel – zero alternations and to account for phonotactic 'impossibilities'.[22]

6.1. Vowel – Zero alternations

Many languages display alternations between vowel and zero. A classical case is formed by the so-called *yer*-alternations in Slavic languages. Of interest here are the typical

[20] If we regard skeletal positions as terminal nodes of syllabic constituents, then, these positions cannot exist in the absence of syllabic constituent structure. In other models, skeletal positions have been granted a more autonomous status (implicitly or explicitly) on the assumption that the syllabic grouping of skeletal positions is not part of the lexical representation, but done later due to a syllabification process. The model discussed here follows Government Phonology in explicitly adopting the view that syllabic grouping is inherent to the lexical representation. Arguments for this position will be provided below.

[21] It has been suggested that the need for such constraints is analogous to the need for constraints that limit the distributions of entities in syntax such as 'traces' and silent pronominal elements. In both cases we are dealing with mechanisms that control the distribution of empty categories.

[22] For a discussion of how EHR interact with stress assignment see Szigetvári and Scheer (2005).

conditions that cause a yer to be 'audible' or 'inaudible'. In general, a *yer* is audible if it followed by a *yer* in the next syllable (Scheer 2004 offers extensive discussion of this alternation in Slavic languages). Hungarian also displays a vowel/zero alternation (Ritter 1995, 2006a) involving the vowel-zero alternation witnessed in *bokor* 'bush, nominative' and *bokrok* ' bush-plural nominative':

(21) a.

O	R	O	R	O	R		
|	|	|	|	|	|		
x	x	x	x	x	x		
|	|	|	|	|	|		
b	o	k	Ø	r	Ø		
[b	o	k	o	r]			'bush, nom.'

b.

O	R	O	R	O	R	O	R
|	|	|	|	|	|	|	|
x	x	x	x	x	x	x	x
|	|	|	|	|	|	|	|
b	o	k	Ø	r	Ø	k	Ø
[b	o	k		r	o	k]	'bush-plural, nom.'

In this example we focus on the rhyme node that is underlined. We note that in (21a) this EHR is realized as a vowel if immediately followed by another EHR. In (21b), however, the same unit is not realized and in this case we note it is followed by a contentful rhyme.

Kaye, Lowenstamm and Vergnaud (1990) argue that the condition for inaudibility in Russian, Hungarian and similar cases[23] can be generalized into a principle of grammar:

(22) An empty-headed rhyme is inaudible only if followed by a non-empty rhyme[24]

Kaye, Lowenstamm and Vergnaud initially term this principle 'Proper Government' and they show that the required relation can be blocked in certain cases, for example if intervening between the governee and governor we find an obstruent cluster. Clearly Proper Government is a head-dependent relationship, but it is non-structural, i.e. it does not correspond to a constituent and the units involved in this relationship are not structural sisters. Following Scheer (2004), I will call such non-structural relations lateral relations and I will refer them as *licensing relations*, ignoring various ways in which government phonologists have made a distinction between government (allowing emptiness) and licensing (allowing content); see Scheer 2004, Ritter 2006a for discussion. I return to this point in section 7.

[23] See van der Hulst (2009) for an analysis of vowel – zero alternations in Yawelmani, and Scheer (2004) for several other cases and relevant references.

[24] This principle would disallow any final empty rhyme; these do appear in some Government Phonology analyses and thus require an additional licensing mechanism. I return to this issues in section 5.3.

The proposed treatment of vowel - zero alternations is compatible with various implementations. The audibility in ungoverned/unlicensed position can be the result of phonetic interpretation (perhaps to be seen as part of phonetic implementation) as in Government Phonology. Alternatively, the audibility could be attributed to a repair rule that inserts a default element. Thirdly, the element in question could be part of the lexical representation without being associated to the rhymal slot. Staying unassociated is in this option only possible if the slot is governed/licensed (cf. Scheer 2004 for a defense of this approach).[25]

Irrespective of the precise details, all models using empty-headed rhymes to account for vowel-zero alternations share the claim that syllable structure is part and parcel of the lexical representation of morphemes and words rather than being derived on the basis of a linear sequence of segments by a syllabification procedure. This must be so, because otherwise the account proposed in this section simply does not work out, unless one would adopt a special type of empty segment (a root node without content perhaps) that would underlie the vowel – zero alternation. Postulating syllabic organization 'underlyingly' raises the obvious question as to whether syllabic organization by itself can be used distinctively, a possibility that is usually held to be unattested. However, if we consider the following pair in Hungarian we have what seems to be a (near)minimal pair which is distinguished solely in terms of syllabic organization:

(23) a. torok 'throat, nom.' torkok 'throat, nom. plur.'
b. park 'park, nom.' parkok 'park, nom. plur.'

(24) a.

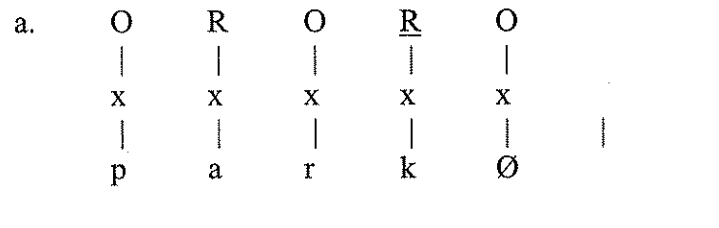
O	R	O	R	O	R
|	|	|	|	|	|
x	x	x	x	x	x
|	|	|	|	|	|
t	o	r	Ø	k	Ø
[t	o	k	o	r]	

b.

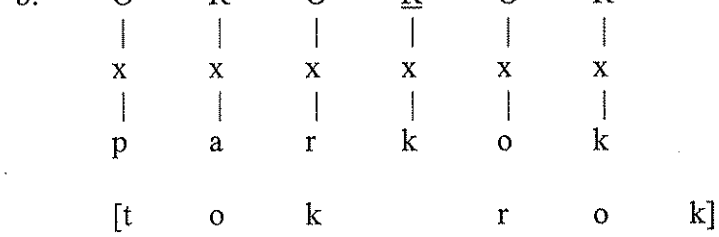
O	R	O	R	O	R	O	R
|	|	|	|	|	|	|	|
x	x	x	x	x	x	x	x
|	|	|	|	|	|	|	|
t	o	r	Ø	k	Ø	k	Ø
[t	o	k		r	o	k]	

[25] In Russian there are two different yer vowels so they cannot both be empty. Without undermining the principle in (22), we would have to differentiate both yer rhymes by assuming differentiating elements that are not associated. Scheer (2004) generalizes this approach to all cases of empty rhymes which has the advantage that it is easier to deal with the fact that empty rhymes do not get realized the same way in all languages. A different formalization of this same idea is offered in van der Hulst (in prep b) who uses the 'old' idea of disjunctive representations (cf. Hudson 1974) which allows a representation of units that are present only under specific conditions.

(25) a.



b.



Examples of this kind illustrate that syllable structure can be distinctive.

6.2. Impossible or improbable phonotactics[26]

In the preceding sections some 'strong' claims (made by proponents of Government Phonology, in particular) have been made with regard to 'possible syllabic constituents'. Firstly, it has been argued that all syllabic constituents are maximally binary and secondly it has been stated that the segmental occupation of syllabic positions in branching onsets is limited: heads can only dominate obstruents and dependents can only dominate sonorants. Less controversial is the claim that in branching rhymes, heads must be vowels.

The question arises how such strong claims can be made if it seems so obvious that there are many languages in which onsets or rhymes exceed the number 2, or where complex onsets are of the type sonorant-obstruent (as in Slavic languages; cf. below). English allows triconsonantal onsets (as in *spring* and *string*) as well as trisegmental rhymes as in (*spoon, warm*) and even quadriconsonantal rhymes, even in uninflected words (*paint, gold, world*).

Three responses are possible to this apparent fact that ternary syllabic constituents are perhaps rare, although not unattested. Firstly, one might regard differences in frequency as irrelevant and claim that linguistic theories of synchronic states of languages must be able to represent, on equal footing, whatever the history of languages produces. In this view, the claim that syllabic constituents are bounded is immediately falsified by an abundance of data. A second view could be that syllabic constituents of unbounded complexity must be represented on equal footing as those that are bounded but not without having the grammar 'note' that increasing complexity comes

[26] This section is a modified version of a section in van der Hulst and Ritter (1999c).

with an increasing number of violations of 'markedness constraints'. This is the approach taken by proponents of Optimality Theory (Prince and Smolensky 1993; Kager 1999).

A third approach, taken by Government Phonologists, is that so-called tendencies (in this case apparent avoidance of unbounded syllabic constituents) suggest that there are *absolute grammatical constraints*. This does not entail that the 'falsifying data' cannot be accounted for and will be ignored. Rather, it entails that these data require more abstract and more complex representations, which are available although not without limits. This third approach thus maintains, in contrary to the first two, that there are impossible languages (Newmeyer 2005).[27]

An important discovery has been that phonotactic patterns that present apparent problems for Government Phonology are typically limited to word edges. It is well known, for example, that extra consonants can occur on the left or right periphery of words, leading to initial or final clusters which we do not encounter word-internally as syllable-initial or syllable-final clusters, respectively.

Extra consonantal options at the periphery of words are often referred to as 'prependix', 'extraprosodic (or extrasyllabic) position', and 'appendix' (cf. Fudge 1969). Sometimes it is proposed that even *two* types of extra positions are allowed word-finally in order to account for so-called 'superheavy VXC syllables' which are followed by a coronal 'appendix' as in Dutch *her-f-s-t* 'autumn', where the /f/ is the extra consonant producing the superheavy syllable (*herf*), while /st/ occupies the appendix position; cf. Trommelen (1983) and van der Hulst (1984).

In Government Phonology the extra consonants are represented as 'degenerate syllables' consisting of an overt onset and an empty-headed rhyme.[28] Similar ideas have emerged in moraic theories of syllable structure (Shaw 1993, Nepveu 1994, Oostendorp 1995). In Kuryłowicz (1952), the peripheral degenerate syllables are stranded onsets, i.e. not followed by an empty nucleus; this approach is also found in Polgárdi (1998) and, perhaps, Dell (1995)[29]. In still other (usually more descriptively oriented) approaches, the extra consonants are not given any special structural status, and it is simply assumed that onsets and codas at word edges can be more complex. This approach receives a slightly more theoretical status by developing the notion of 'extrasyllabicity' (Rubach and Booij 1990).

With the option of having extra word-peripheral consonants, a language can have CV as its *only* syllable type, allowing CCV word-initially and/or CVC word-finally, to be represented as C∅CV and CVC∅. In cases of this sort initial CC clusters often contain sequences other than obstruent-sonorant which is a further indication that these initial

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[27] A sharp difference between Dependency Phonology and Government Phonology has always been that proponents of the former model, while making available the essential representational apparatus that both models use (binary, headed constituents) have not been inclined to translate 'tendencies' into 'absolute constraints'. Thus, DP has been focused on introducing fundamental concepts and less on imposing restrictions. This, of course, does not mean that such restrictions cannot be added, or built in (cf. van der Hulst 1995 for a discussion of this point).

[28] Rennison and Neubarth (2003) have a proposal involving a notion 'strength' which determines which consonant can precede or follow which other consonant.

[29] Cf. Dell (1995:19): "we are assuming in effect that words such as *garde, marbre*, etc. end in a degenerate syllable, i.e. a syllable whose rime consists of a nucleus which is not associated with any distinctive features." A few lines later, however, Dell says that "the final empty nucleus does not belong to the lexical representations."

sequences do not form true onsets. In other cases, the 'core' syllable itself is more complex (assuming that branching is a parametric option), allowing CC initially and VC finally. In such a case, word edges can also allow extra consonants, arriving at the possibility of word-initial tri-consonantal clusters (always involving initial /s/) and word-final superheavy syllables (-VVC/-VCC), to be represented as C∅CCV[30] and CVXC∅.

The guiding idea of Government Phonology is that an explanatory structural description of the phonological structure of words may call for postulating a somewhat abstract organization which contains units or terminal nodes that remain empty. In addition, Government Phonology, as shown above, appeals to principles (such as 'Proper Government') that control the distribution of these empty nodes.

I believe that the observation that certain complexities are limited to edges is quite crucial to counter the simplistic view that the syllable template for a language can be defined as the sum total of word-initial and word-final clusters separated by the set of vowels. I will now discuss a few cases which show that certain complexities are indeed confined to word edges.

An inspection of Dutch syllable structure (as found in Trommelen 1983, van der Hulst 1984) reveals that Dutch 'onsets' can only exceed the number of two when at the left word edge, in which case tri-consonantal clusters are allowed consisting of /s/ + obstruent + liquid:[31]

(26)	stronk	'trunk'
	splijt	'split'
	sprong	'jump'

When such a tri-consonantal cluster is found word-internally (between two vowels), without the interference of a strong morpheme boundary, it is split up by a syllable division as follows:[32]

(27)	mis.tral	'mistral'
	es.planade	'esplanade'
	Cas.tro	'Castro'

Independent evidence for this syllable division (as Trommelen 1983 points out) is that the vowel to the left of /s/ is *lax*, which is a signal of being checked by a following tautosyllabic consonant (cf. van Oostendorp 1995). The claim that word-initial clusters need not be syllable-initial clusters can even be shown on the basis of seemingly well-behaved *bi*-consonantal clusters consisting of an obstruent and a sonorant:

(28)	a.	gnoom	'gnome'	b.	Ag.nes	'Agnes'
		slaaf	'slave'		Os.lo	'Oslo'
		tjiktjak	'type of bird'		at.jar	'atjar'

[30] Kaye (1992) proposes to represent clusters that start with /s/ as ∅/s/C(C)V which explains, for example, why in Spanish an initial /ɛ/ vowel appears in such cases.

[31] See Ewen (1982) and van de Weijer (1996) for analyses in terms of 'complex segments'.

[32] There are problematic cases such as the word 'extra' [ɛkstra] which either has to much in its coda or too much in its onset.

The possible initial clusters /gn/, /sl/, /tj/ are split up when they occur intervocalically. This shows that the only 'real' branching onsets are those consisting of an obstruent (excluding /s/) followed by a liquid (cf. Trommelen 1983).[33]

Another language that has word-initial clusters with more than two consonants is Polish (Rubach & Booij 1990, Gussman and Kaye 1993, Cyran and Gussman 1999, Rowicka 1999):

(29)	pstry	'mottled'
	bzdura	'nonsense'

Evidence for the word-internal syllabification of such clusters is harder to obtain given their scarcity in underived words (cf. below), but this is in itself an indication that the clusters may be restricted to the word-initial position. In addition to having such complex clusters, initial bi-consonantal clusters appear to allow many combinations that violate the so-called *Sonority Sequencing Generalization* (SSG; Selkirk 1982, Clements 1990); but see Cyran and Gussmann (1999) and Scheer (2007) for restrictions that do exist:

(30)	ptak	'bird'
	scheda [sx]	'inheritance'
	skok	'jump'
	mnoz.yc'	'multiply'
	lnu	'linen, gen.sg.'
	rtęć	'mercury'

Rubach & Booij (1990) note that the options for word-internal onsets are considerably restricted, suggesting that a cluster like [-rt-], allowed word-initially, is heretosyllabic word-internally: *kar-ty* 'cards'. This is very similar to what I reported for Dutch above.

The realization that clusters that exceed the size of two consonants as well as clusters that (in addition) violate the SSG are restricted to the word-initial position, frees the way to claiming that clusters that are grammatical at the left edge of words are not necessarily true onsets, which in turn triggers an investigation into their special nature.

Many phonologists have treated the extra options at the left edge of words by allowing an extrasyllabic consonant in that position (cf. Rubach & Booij 1990 for Polish), treated as stranded onsets by some (cf. Kuryłowicz 1952). This approach, of course, fails to impose any restrictions on how many consonants can thus be adjoined; there never seems to be more than one. Others have suggested that the apparent sequence of two consonants may in some case involve complex segments (s+C clusters; cf. van de Weijer 1996). The approach that is advanced in Government Phonology (mentioned above) claims that the extra material involves 'degenerate' syllables consisting of onsets followed by empty rhymes.[34]

[33] For a government-based analysis of Dutch syllable structure cf. van der Hulst (2003b).

[34] This recasting of extrasyllabicity in terms of syllables with an empty-headed rhyme might help explaining why 'extrasyllabic consonants' are more limited on the left edge of words. See, in this connection, Lowenstamm (1999).

With respect to rhymal structure we can make similar observations. Languages such as Dutch and English allow word-final 'rhymes' that are rather complex:

(31)	*Dutch*		*English*
	oogst	'harvest'	sixth
	ernst	'seriousness'	blast(s)
	vreemd	'strange'	clown(s)

In each case, we find lax/short vowels followed by up to 4 consonants (VCCCC), or tense/long vowels followed by up to 3 consonants (V_{tense}CCC or VVCCC). An inspection of word-internal syllables demonstrates to us that such very complex rhymes are rather rare when they are not word-final. This leads us to the descriptive generalization that 'superheavy' syllables (i.e. syllables ending in overcomplex rhymes) are limited to the right edge of words; this observation is also commonly made with reference to Arabic languages. The idea that word final consonants may not belong to the core syllable was made explicit in Fudge (1969, 1987) who suggested a word-final constituent which he called the appendix, a notion that was subsequently adopted in other work (cf. Selkirk 1982, van der Hulst 1984).[35]

However, not all instances of impossible phonotactic regard edges. There are also instances of impossible phonotactics that involve interludes consonant sequences that violate the 'syllable contact law' proposed in Murray and Vennemann (1983) which states that the edge consonant (i.e. onset head) should not be less sonorous than the preceding coda consonant. Vennemann and Murray state this as a dispreferred pattern, but Government Phonology has translated this into an absolute requirement. This, then, makes the heterosyllabic sequences in (32a) suspect:

(32)	Turkish		
	a.	azmi	'resolution'
		kavmi	'tribe'
	b.	metni	'text
		kabri	'tomb'
		kudret	'power'

In fact, given that it is generally assumed that Turkish does not allow complex onsets, the clusters in (32b) must be analyzed as heretosyllabic which causes more violations of the syllable contact law. Denwood (2006) and Charette (2004) provide extensive analyses of Turkish which clearly demonstrate all these alleged interludes behave as sequences of onsets (with intervening EHR).

A further complication is raised by so-called syllabic consonants, which occur, for example in English in unstressed syllables, but even in stressed syllables in many other languages; cf. Bell 1978):

[35] Morphological structure is relevant in these cases. Affixes can create additional complexities that require recognition of the fact that these affixes do not belong to the same phonotactic domain as the stem, but instead form an independent domain.

(33) *English*

bottom	[batm̥]
bottle	[batl̥]
water	[wɑtr̥]

Here we seem to have the wrong segment type (namely a consonant) in the rhymal head position. Rather than relaxing what kind of segments can make up nuclei (at the phonotactic level), proponents of Government Phonology have suggested that such syllabic consonants are not rhymal heads, but, for example, a coda preceding by an empty-headed rhyme (cf. 17 above); see Scheer (2009).

Summarizing, we have considered the following circumstances:[36]

(34)
- a. An impossible onset
  - i. Too many consonants (English, Georgian[37])
  - ii. The wrong combination (Polish)
- b. An impossible rhyme
  - i. Too many segments (English *spoon*)
  - ii. The wrong segment (syllabic consonant, e.g. English *bottom*)
- c. An impossible interlude, i.e. violations of the 'syllable contact law' (Turkish)

All these circumstances can be represented by appealing to EHRs:

(35)

ai.	(sV)(priŋ)
aii.	(lV)(nu)
bi.	(tow)(nV)
bii.	(bot)(tVm)
c.	(a)(zV)(mi)

Can all cases of excess be analyzed in terms of just a single EHR that is licensed in terms of the principle in (22)? Things are not always so simple. Let us demonstrate this with onsets. If the principle in (22) is correct this would predict that the complexity of initial clusters is limited to a sequence of two possible onsets. Cyran and Gussman (1999) explain that Polish might be more complicated than that and they propose an additional principle (*Interonset Licensing*) which allows one extra onset (and following empty rhyme). A similar case is made in Ritter (2006) for Georgian, notorious for its onset complexity.[38] It is to be expected that greater empirical coverage is going to increase the

[36] In all cases discussed, the generalization that certain complexities only occur at word edges must be qualified by saying that the notion 'word' here refers to non-compounded, non-prefixed words, and words that do not contain certain classes of suffixes, such as so-called 'level II' affixes and inflectional affixes. Exactly how to characterize the scope of the syllabic domain is not a trivial matter; however; cf. Kaye (1995).

[37] See Bush (1997), Butskhrikidze (2002) and, for a Government Phonology analysis, Ritter (2006a).

[38] Interonset Licensing creates a head-dependency relationship between two onsets, the first one (the head) being more sonorous than the second one. This creates a 'pseudo-onset'. It is assumed that an EHR caught

theoretical apparatus and it is the prerogative of every researcher to decide at some point that the framework is getting too rich, and that a more radical revision is required. Perhaps more obvious it the fact that final empty-headed rhymes can not be licensed in terms of principle (22). Thus, proponents of Government Phonology propose 'final licensing' as an additional licensing mechanism.

Some languages even go further beyond all the complexities that have so far been discussed, most dramatically by allowing words to consist of sequences of consonants only, some of which are called 'syllabic' (syllable peaks) (Hoard 1978, Dell & Elmedlaoui 1985):[39]

(36) *Nuxalk* (formerly called Bella Coola; Baghemil (1991)

xsc'c	'I'm now fat'
lxwtlcxw	'you spat on me'

Imdlawn Tashlhiyt Berber (Dell & Elmedlaoui 1985, 2002)

tftkt	'you suffered a sprain'
ssrksxt	'I hid him'

With respect to the Nuxalk facts, it has been suggested that such sequences should be taken as evidence for the claim that syllables can consist of just onsets (Hockett 1955), that the segmental string lacks syllable structure (Newman 1947), that there is only partial syllable structure (Baghemil 1991). Dell & Elmedlaoui maintain that words in Imdlawn Tashlhiyt Berber are completely syllabified necessitating that all consonant types can function as syllabic peaks. An alternative analysis of similar facts in another dialect can be found in Guerssel (1990), who postulates empty nuclei.[40]

7. Licensing of marked constituents

In the preceding sections we have seen several non-structural (lateral) head-dependent relations, referred to either as government or licensing relations. Ignoring, for the moment, final licensing, I have introduced 'proper government' which licenses empty rhymes, but other licensing mechanisms have been proposed, for example in Kaye (1990a), Charette (1990), and later works.[41] Taken together these mechanisms suggest a

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within such a relationship is allowed to remain silent without being 'properly governed', i.e. licensed by a following contentful rhyme (cf. 22). This then allows [O∅O∅OR..., where ∅ stands for an EHR.

[39] In both cases we need to be careful in that transcriptions may not reveal 'epenthetic vowels'. Dell and Elmedlaoui (1985, 2002) offer detailed discussion of the status of such vowels, but we do not know whether the Nuxalk data that 'go around' are detailed enough in this respect.

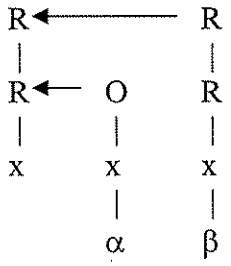
[40] A complication in evaluating the different analyses involves subtle differences in the emergence of schwa-like epenthetic sounds.

[41] Collections of Government Phonology work can be found in two special issues of the journals *Phonology* (1990, Issue 7) and *The Linguistic Review* (2006, Issue 23/4). See also many articles in Ploch (2003). A number of dissertations have been produced coming from SOAS (London); also see the *Soas Working Papers in Linguistics*. The papers in Cyran (1998) are also Government Phonology and there are some nice ones. The book is available from this address: http://www.kul.lublin.pl/art_2716.html. Collections of DP work are: Anderson and Ewen (1980), Durand (1986), Anderson and Durand (1987). There are, in addition, many other book length Government Phonology studies of single languages (often originally dissertations)

generalization that is explored in van der Hulst (2006b).[42] I will here summarize the proposal. The central idea is that a 'marked' constituent (branching or empty-headed) cannot occur freely but must be licensed by constituents that follow which must be non-empty. Specifically, it would seem that all the licensing/government principles/parameters that Government Phonology has been proposing can be subsumed under a single generalization: *marked* constituents must be locally licensed by following *contentful* constituents (only R in case of marked O, and both O and R in case of marked R.

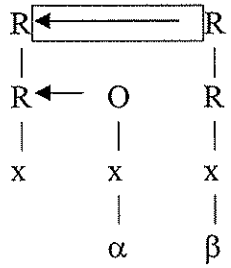
An example of the general licensing scheme is as follows:

(37)



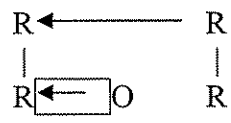
This scheme says that an empty-headed rhyme must be followed by a contentful onset and a contentful rhyme. The second requirement was stated explicitly in Government Phonology under the heading of 'proper government'. The original idea was that an empty-headed rhyme that was not properly government would have to 'become audible' as a matter of phonetic interpretation. This view accounts for what other might see as a repair rule (insertion of an element to make the rhyme audible):

(38)



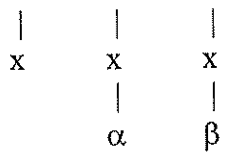
The second requirement is noted in Charette's (1990) treatment of schwa-deletion in French. Words like *dehors* [dəɔr] 'outside' do not allow the schwa to become silent. The idea in this analysis is that a French schwa is represented as an empty rhyme which is not governed, or as I would say: licensed. In this type of example we see that the schwa must be audible in hiatus even when there is a following non-empty rhyme and the reason seems to be that there is no onset, or an empty onset:

(39)



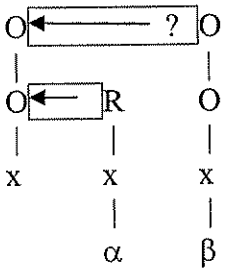
such as, for example, Yoshida (1990), Charette (1991), Brockhaus (1995), Ritter (1995), Rhee (2002), Polgárdi (1998), Rowicka (1999), Dienes (2000) and Szigetvari (2000).

[42] This proposal does not cover cases for which Government Phonology invokes 'final licensing'.



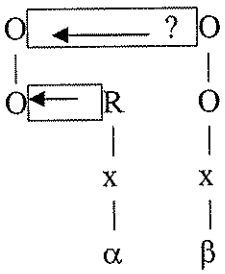
Interestingly, it is not obvious whether empty onsets also require double licensing. Here I need to distinguish between an empty-headed (but pointed) onset (such as h-aspiré in French) and onsets that are truly absent. It is probably trivially true that no cases of two consecutive empty-headed onsets have been reported, but that does not mean that such a sequence is illegal, given that such units appear to be fairly rare in the first place. Hence, the case for the OO relation in (40) is weak:

(40)



What about the absence of O, or at least the absence of a O that has a skeletal position?

(41)



The OR relation seems supported by fact that empty-headed rhymes seem to always require the presence of a contentful onset, which boils down to the non-existence of an entirely empty syllable (i.e. OR sequence). It is here that we see an advantage of adopting 'pointless' Os because unless we assume these units the constraint against entirely empty syllables could not be stated as part of the licensing paradigm that this section develops.

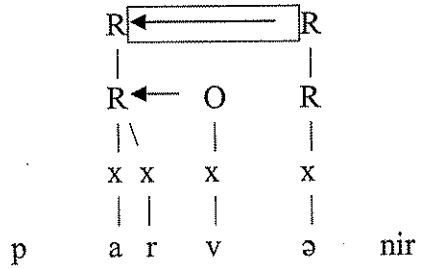
The OO relation in (41) would be warranted if it would be true that languages avoid double hiatus, e.g. string like /…a – o – i…/ (which does occur in an English word *maoist*). A constraint against double hiatus has not, to my knowledge, been proposed.[43]

Having discussed licensing constraints on empty-headed constituents, which, as shown, are well supported for rhymes and less so for onsets (whether pointed or pointless), I now turn to the licensing requirements on branching constituents.

[43] In fact, since long vowels are represented as birhymal in this approach, any long vowel that is not preceded by an overt onset (as in English *eel*) presents a case of two consecutive pointless Os.

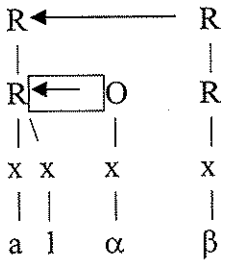
Let us first consider branching rhymes that end in a coda consonant? Van der Hulst suggests that these two must be followed by a contentful rhyme which can be demonstrated by considering certain facts of French. Charette (1990) argues that the schwa in (some varieties of) French cannot be silent in words like *parvenir*. She proposes an account which is different from the one I suggest here.[44] The schwa is required to be present so that it can "license the /v/ to govern the preceding coda /r/. In the spirit of Harris (1997) I suggest that the licensing goes directly from the rhyme with the schwa to the preceding branching rhyme.[45]

(42)



Let us now ask whether a branching rhyme must also be licensed by a following contentful onset.

(43)



It would seem that (43) is well motivated and, in fact, known as 'coda licensing' in Government Phonology (Kaye 1990a) which instead construes the relevant mechanism as the required presence of an onset following a coda consonant.

A second case of branching rhymes might be rhymes with a long vowel. I will assume here without discussion that all long vowels are necessarily bi-rhymal. If we were to reject that idea and allow monorhymal long vowels, it would seem, at first sight that we can explain the well-known 'closed syllable shortening effect' in terms of the licensing requirements on branching rhymes that we saw for closed syllables. Closed syllable shortening is witnessed by alternations in, for example, Yawelmani (Kaye 1990b, Yoshida 1993, van der Hulst 2009):

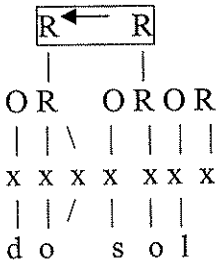
(44) do:s – ol 'report, dubitative' dos – hin 'report, nonfuture'

[44] Also see Charette (1992, 2003).

[45] Perhaps crucially, Charette (1990: 240) claims that schwa deletion is not only impossible if an 'impossible onset cluster' like 'vn' would arise, but also in cases like *tourterelle* 'turtle dove' where the resulting combination /tr/ would be a fine onset. I am aware of the fact that the facts of schwa deletion are not always clear and it is therefore necessary to support the RR relation in (39) with additional cases.

Kaye (1990a) proposes to *not* account for the appearance of a short /o/ in *doshin* by appealing to a shortening that is caused by the vowel appearing in a closed syllable and a constraint on rhymes not exceeding two positions. His reluctance to accept this traditional account stems from the fact that in Government Phonology syllabic affiliations of segments must remain unchanged. In addition, there is, in fact, no compelling argument for saying that the vowels that shorten are in closed syllables; shortening takes place before any two consonants no matter what there sonority slope. In other words, 'resyllabification' is not allowed in Government Phonology. The shortening effect is instead attributed to the fact that a branching rhyme must be licensed by a following contentful rhyme. This is the case in *do:sol*:

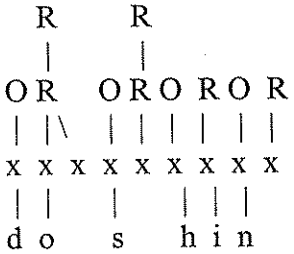
(45) a.



/do:s/ - ol/ -> do:sol

However, in the case of underlying *do:shin* the underlying long vowel is followed by an EHR and this would imply that the branching rhyme that supports the long vowel is not licensed:

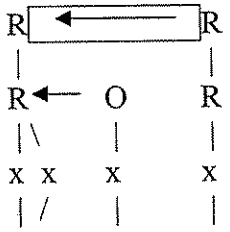
(46)



/do:s - hin/ -> doshin

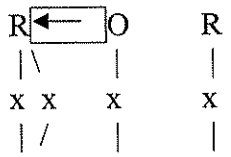
Analogous to (42), it would seem, then, that long vowels *as branching rhymes* must also be licensed by a following overt rhyme:

(47)



Let us now ask whether a long vowel as branching rhyme must also be licensed by a following contentful onset (analogous to 43):

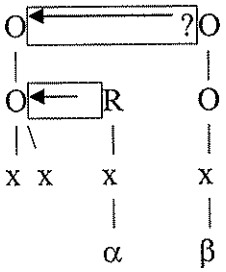
(48)



(48) says that if long vowels are indeed branching rhymes we would expect that they must be followed by an overt onset, but there is no support for that restriction. Hiatus after long vowels is quite common. In English vowels to the left of hiatus are, in fact, obligatorily long. The distribution of long vowels, it would seem, suggests that long vowels are *not* branching rhymes.[46]

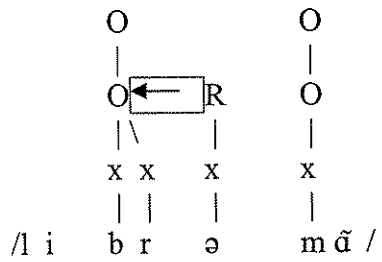
Finally, to complete 'the licensing paradigm' we will address the need to license branching onsets; recall that we found little support for the notion that empty onsets require licensing by a following overt onset (cf. 41 lower arrow), while they do require licensing in terms of a following overt rhyme (cf. 41 upper arrow):

(49)



Again there seems to be no evidence for the OO relationship. Strings like /bri.o/ do not seem problematic in languages that allow both branching onsets and empty onsets. However the OR relationship is well-motivated as demonstrated by the other case that Charette (1990) discusses as an instance of 'license to govern', the idea being that /b/ in (50) must be licensed to govern its dependent /r/ by an audible nucleus. Hence after a branching onset schwa must be pronounced. In line with the system of licensing developed here, I interpret this case as direct licensing of a branching constituent.

(50)



The following table summarizes the results:

(51)

[46] I refer to Lowenstamm (1996) and van der Hulst (2009) for accounts of closed syllable shortening effects under bi-rhymal analyses of long vowels. The latter suggests that an unlicensed EHR is only made audible if preceded by an overt rhyme. This does not apply to the second (empty) rhyme of a long vowel which is not preceded by an overt onset.

	Homogeneous licensing	Heterogeneous licensing
Empty Rhyme	RR (proper government)	RO (*dehours*-case)[47]
Empty Onset	OO [not needed]	OR ("*empty syllable")
Branching Rhyme	RR (*parvenir*-case)	RO (coda licensing)
Branching Onset	OO [not needed]	OR (*librement*-case)

Van der Hulst (2006b) suggests that the apparent non-existence of OO licensing would find a principled explanation if one assumes that there is no O-projection level, comparable to the R-projection level. Only the latter can be independently motivated by the fact that R is the head of the OR package.

In conclusion, if we assume that empty and branching syllabic constituents are *deviations* from the unmarked contentful, non-branching case, it would seem that all the licensing/government principles/parameters that Government Phonology has been proposing can be subsumed under a single generalization: *marked* constituents must be locally licensed by following *contentful* constituents (only R in case of marked O, and both O and R in case of marked R).[48] This makes intuitive sense because otherwise proliferations of marked, that is empty-headed and branching, constituents, would lead to 'excessive' consonant sequences.

We have seen two motivations for the use of EHRs: vowel-zero alternations and 'impossible phonotactics'. While in the former type of analysis, EHRs are motivated in terms of observable alternations, this is not so in the latter case. For this reason alone, one might call their use for these types of case unacceptable. There is nothing inherent to a dependency approach, not even one that limits itself to binarity, which compels the postulation of EHR in case phoneme sequences overstep the boundaries of what is considered 'unmarked'.

8. Other recent developments

Neither Dependency Phonology nor Government Phonology are 'static' models. Since their inception modifications have naturally been proposed. As for DP, I consider Radical CV Phonology primarily a DP development(van der Hulst 2005a), but I also refer to ongoing work by Anderson (2002, 2003, 2004, 2006), and somewhat more distantly related work by Smith (2000), Humbert (1995), Botma (2004) and van der Torre (2003).

Radical CV Phonology pursues the idea that the internal and external syntax of phonological segments can be represented in terms of just two primitives (labeled C and V) which are intrasegmentally grouped into three sets (place, manner and laryngeal) and extrasegmentally represent the syllabic constituents into which segments are grouped.

[47] Van der Hulst (2006c) provides further motivation for this licensing case with reference to what is called 'resolution' or 'reduction' in the Government Phonology literature. If a stem ends in a EHR and a following suffix start with an empty onset, a violations of heterogeneous licensing of empty rhymes, both empty constituents are 'removed'.

[48] An issue that needs more research is the question whether licensors, in addition to being non-empty, are also preferably non-branching.

Although monovalent in nature, the two primes are clearly antagonistic or polar.[49] As mentioned in section 4.1., it is possible to conceive of the elements C and V as 'subprimal' units which, in conjunction with the group labels (place, manner, laryngeal) *define* the 6 elements that might be sufficient to characterize all possible phonological contrasts.

There also have been developments that have led to interesting varieties of Government Phonology. Van der Hulst and Ritter (1998, 1999, in prep.) offer a modification of some aspects of Government Phonology (such as removing the distinction between nucleus and rhyme). In addition they develop a typology of the various licensing relationship that can be distinguished. Scheer (2004) discusses both Government Phonology and varieties in some detail.

Secondly, I mention an influential idea put forward in Lowenstamm (1996; developed in 1999, 2003) which is the proposal to universally rule out branching syllabic constituents. This effectively reduced all languages to 'strict CV' languages. In this proposal all alleged codas are onsets and all long vowels are bi-rhymal. Moreover, all branching onsets are sequences of onsets with intervening EHR. Lowenstamm (2003) proposes to treat 'complex onsets' differently, namely as complex segments which are represented under a single skeletal position.[50] Lowenstamm's strict CV idea has been adopted in Scheer (2004) who offers a very detailed application of this approach.[51] Scheer refers to his version of this approach as a 'lateral approach' to phonology because rather than appealing to (syllabic) constituency and hierarchy all relationships involve lateral connections between O and R nodes (which he notates as C and V; the distinction between syllabic node and skeleton no longer being necessary).[52] I also refer to Polgárdi (1998), Rowicka (1999) and Szigetvari (1999, 2000) for applications of this approach.

A third line of interest is offered in Cyran (to appear). Cyran, following the approach promoted in Harris (1990, 1994), defends the idea that "the basic principles of phonological organization boil down to the interaction between the strength of nuclei as licensers of phonological structure and various non-rerankable scales of complexity occurring at different levels of phonological representation. The licensing relation between nuclei and the preceding onsets on the one hand, and governing relations between consonants, which are to a great extent determined by their internal melodic structure, allow us to view the phonological representation as a self-organizing system." (Cyran, to appear). Cyran implements this approach within the context of Lowenstamm's strict CV theory.

Fourthly, Pöchtrager (2006) offers a rather different version of Government Phonology in which the role of former elements (in particular the elements H and ʔ, responsible, among others, for the difference between fricatives and stops[53]) are taken over by more elaborate syllabic configurations. A different approach that also eliminates

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[49] One might summarize the RCVP on primes as follows: all primes are monovalent; there are only two (polar) primes. This sounds as the ultimate compromise between unary and binary approaches.

[50] This proposal is similar to Duanmu's CVX theory (Duanmu 2008) who, unlike Lowenstamm allows branching rhymes (VX). Duanmu also argues that alleged complex onsets are complex segments.

[51] This work also contains a very useful and detailed discussion of other varieties of Government Phonology. See Cyran (2006) for an extensive review.

[52] This approach is, in certain respects, prefigured in Takahashi (1993, 2004), who extends Harris' (1997) notion of licensing inheritance.

[53] Jensen (1994) already had questioned the need for the element ʔ.

the elements for 'continuancy' is offered in Ritter (1997). Here, continuancy is expressed in terms of intrasegment headedness (stops are headed and fricatives are headless), which has going for it that it simply extends the use of the contrast between headedness and headlessness from vowels to consonants. In vowels, others had already argued that the difference in 'ATR' could be expressed in this way (cf. Harris and Lindsey 1995).

The results obtained in these alternative approaches, as well as the one presented in this chapter, are not entirely incompatible. In some respects they are, but in others it is likely that all this work contributes to a 'dependency-based' or indeed 'head-driven' theory of phonology.

10. Concluding remarks

The present chapter has offered an overview of an approach to phonological structure that relies heavily on the role of head-dependency relations. In addition, it uses only monovalent primes and, in some varieties, also 'element grouping'. It is interesting to note that all three theoretical devices (headedness, monovalency and grouping) were originally introduced in the early seventies by proponents of Dependency Phonology, only to emerge in the mid seventies and eighties as independent developments within 'mainstream generative phonology'.

Varieties of dependency-based phonology (Dependency Phonology, Government Phonology, Radical CV Phonology etc.) are primarily theories about phonological representations, which are, as such, compatible with various views on the *derivational* aspect of phonology, i.e. dealing with 'invariance', i.e. alternations (allophonic and allomorphic). Dependency Phonology has essentially adopted a traditional rule-based approach, in principle allowing for extrinsic ordering, but in practice having been insufficiently applied to the kind of data that seem to require this mechanism.[54] Government Phonology has been advocated as a 'no rule' approach, seeking an account of phonological structure and invariance that is entirely constraint-based. However, as pointed out in section 2, the mechanism of 'phonetic interpretation' seems to function as a repair component, extending the domain of elements and assigning a null interpretation to elements that are not licensed. Van der Hulst (2009) points out that we can also implement Government Phonology (or other variants of the models discussed here) in a declarative framework which accounts for invariance by unifying lexical representations (which themselves are very specific constraints) with constraints that 'add' information, or in terms of lexical representation that contain disjunctions (called 'hyperspecification', underspecification being a specific case); cf. Scobbie, Coleman and Bird 1996.

Yet another way of dealing with invariance is to invoke an Optimality Theory style approach. A combination of, for example, Government Phonology and Optimality Theory can be found in Polgárdi (1998) and Rowicka (1999).[55] What these works clearly demonstrate is that issues of representation are, in principle, independent of issues of derivation, although it seems obvious that no derivational theory can even be conceived

[54] This does reflect a bias against overly abstract underlying representations. I would say that DP favors a fairly 'concrete' phonology and thus will tend not to rely on extrinsic orderings.

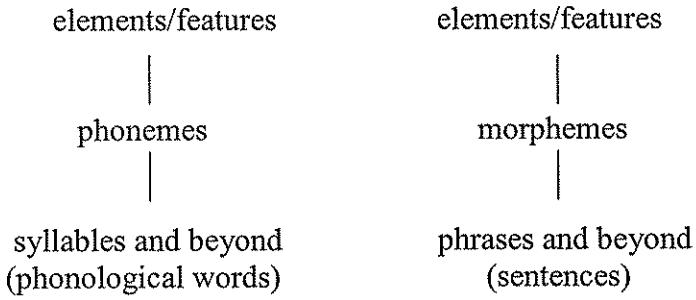
[55] Independent of OT, the notion of constraint ranking was invoked in Charette (1990) and Cyran (1996), both Government Phonology accounts.

in the absence of a solid and explicit representational theory. It seems to me that the models discussed in this chapter primarily seek to develop such a theory. To use an apt phrase by Brandao De Carvalho (2002) "constraint-based theories need theory-based constraints".

An aspect of Optimality Theory that has not been explored in this chapter is that ranking between any two constraints can be interpreted as an instance of dependency relations between these constraints. It would, therefore, be in the spirit if dependency-based approaches to explore the use of dependency relations between constraints.

Crucial reliance on the notion 'head' (and 'dependent') suggests an analogy between phonology and syntax. I believe that the analogies between syntax (morphotactics) and phonology (phonotactics) are real and deep (van der Hulst 2005b, 2006c; contrary to Bromberger and Halle 1989).[56] Both systems form a complementary and essential part of the grammar of human languages and it would seem that both are relying on the same 'logic', i.e. a system of 'intermediate primitives' (morphemes and phonemes, respectively) and a combinatorial system of a specific sort (binary-bounded, headed). The intermediate primitives can be analyzed into a system of features or elements, which are, then, the ultimate primitives, and another combinatorial system:

(49)



With good reason, linguists have argued that both combinatorial systems make reference to the head – dependent asymmetry (whether taken as basic or augmented to a constituency) and perhaps also share binarity. The idea that different parts of the grammar rely on the same kind of computational mechanisms has been termed 'Structural Analogy' by John Anderson (e.g. Anderson 1985, 1992, 2003, 2006; van der Hulst 2005b). We still have different modules (i.e. phonotactics and morphotactics), but rather than expecting that these modules are organized totally differently (just because they are 'autonomous'), it makes more sense, Anderson suggests, to adopt the working hypothesis that the human cognitive system replicates simple and successful procedures in different modules.[57]

If this view is correct, we require a notion of head (and dependent) which truly generalizes over both domains and not one that has been tailored to morphotactics (only to then claim that it doesn't apply to phonotactics). The claim that the combinatorial system for morphotactics is recursive, while that for phonotactics is not, is irrelevant to the analogy. Phonotactics primarily caters to phonetics (which has a rhythmic, iterative structure), while morphotactics primarily caters to semantics which is inherently

[56] See the articles in Bermudez-Otero, R. and P. Honeybone (2006).

[57] There is, in fact, no need to believe that these mechanisms are 'linguistic' rather than 'cognitive' (cf. Anderson 2006).

recursive. The need for embedding (i.e. recursion) originates in semantics, phonetics requires no more than iteration. This does not make morphotactics the core of human language. It means that recursion is an available cognitive device, used where needed.