Studies in Generative Grammar 45

Harry van der Hulst
Nancy A. Ritter
(Editors)

The Syllable

Views and Facts

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Contents

2 Theories of the syllable

Harry van der Hulst & Nancy A. Ritter

1. Introduction

The goal of this chapter is to discuss some general issues in syllable theory. Section 2 presents some of the more difficult data that any theory of syllable structure or phonotactics must address, specifically involving complex consonant clusters. Section 3, then, discusses a number of approaches to syllable structure, comparing them and showing the equivalences and differences. In section 4, we address a number of fundamental questions regarding the level of grammar at which phonotactics must be stated, and how many levels are needed. In section 5, we offer some conclusions.

2. Some examples of syllabic complexities

Accepting the idea that the phonotactic structure of words can be largely understood by assuming that segments are organized into syllable-sized units, of which words can contain several occurrences, we start out by observing that in some languages, words show a simple repetition of CV syllables, without there being any further complications at the edges of words.[1] The number of repetitions of the CV-unit that is allowed per 'word' is typically not unlimited but instead depends on general constraints which determine the maximal size of feet and prosodic words in terms of 'prosodic templates' (cf. Kager 1994, van der Hulst & Klamer 1996). Focusing our attention on the structure of the syllable unit itself, we observe that many languages seem to allow various deviations of this basic CV scheme. Traditional descriptive and theoretical terminology labels such deviations as 'complex onsets', 'closed syllables', 'complex codas' and 'intervocalic clusters'.

An important discovery has been that the deviations from the simple schema can be limited in some languages to word edges only. 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'; sometimes it is proposed that even *two* types of extra positions are allowed word-finally in order to account for so-called 'superheavy 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 some frameworks, such as government phonology (Kaye, Lowenstamm & Vergnaud 1990, and chapters 6-11 in this volume), the extra consonants are represented as 'degenerate syllables' consisting of an overt onset and an empty nucleus. Similar ideas have emerged in recent moraic theories of syllable structure (Shaw 1993, Nepveu 1994). 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 Dell (1995). 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; cf. chapter 9 in this volume for a discussion of such differences with respect to initial clusters in Hungarian.

With the option of having extra word-peripheral consonants, a language can have CV as its *core* syllable, allowing only CCV word-initially and/or only CVC word-finally. In other cases, such as Dutch, the 'core' syllable is more complex, allowing CC initially and VV or 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).

When edges do not license extra material, the core syllable simply recurs throughout the whole word. As mentioned, the core syllable can be the simple CV unit but may also represent a set of syllable types (as in Dutch) such as CV, CCV, CVC, CCVC, V, VC, which is collapsed into the template (C(C))V(C).[2]

However, things may not always be so straightforward. It has been argued (especially within government phonology; cf. chapter 6) that some languages which superficially show various types of complications throughout the word, must still be analyzed as 'strict' CV languages.[3] For example, in such cases, arguments can be provided for representing apparent cases of initial consonant clusters (*#CCV*) as *#CvCV*, where the small *v* stands for 'empty nucleus'. Likewise medial *-CC-* can be analyzed as *-CvC-*, and final *C#* as *Cv#*. An analysis of this type has been proposed for Leti, a language allowing all these patterns, in van der Hulst & van Engelenhoven (1995) and van der Hulst & Klamer (1996).

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 appeals to various principles that regulate the distribution of these empty nodes. It is also possible, however, that complications of the CV schema that occur throughout the word reflect genuine enrichments of the syllable template. Proponents of government phonology have proposed that the complications are limited to headed binary branching structures so that only bi-positional onsets and bi-positional nuclei (or rhymes) are allowed.[4]

We 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. We now turn to a brief discussion of a few cases which show that certain complexities are 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:

(1)	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:

(2)	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:

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

The possible initial clusters /gn/, /sl/, /tj/ are split up intervocalically. This shows that the only 'real' branching onsets are those consisting of an obstruent (excluding /s/) followed by a liquid (cf. Trommelen 1983).[5]

Another language that has word-initial clusters with more than two consonants is Polish (chapter 8, this volume, Rubach & Booij 1990, Rowicka 1999):

(4)	pstry	'mottled'	
	źdźbl-o	'blade'	[ʒdʒbwo]
	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 almost any combination of two consonants (but see chapter 8, this volume, for a discussion of many restrictions). The possible combinations are clearly not restricted to those that obey the so-called *Sonority Sequencing Generalization* (SSG; Selkirk 1982, Clements 1990):

(5)	ptak	'bird'
	scheda [sx]	'inheritance'
	skok	'jump'
	mnożyć	'multiply'
	lnu	'linen'
	rteć	'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 heterosyllabic word-internally: *kar-ty* 'cards'. This is very similar to what we 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.

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). Others have suggested that the apparent sequence of two consonants may in some case involve complex segments (s+C clusters; cf. van de Weijer 1994 and the discussion of Wiese (1995) in chapter 7, this volume). The approach that is advanced in government phonology (mentioned above) claims (in some respects following Kuryłowicz' 'stray onset' analysis of Polish) that the extra material

involves 'degenerate' syllables consisting of onsets followed by empty rhymes (cf. Ritter 1995 for initial clusters in Hungarian). Some of these options are perhaps not mutually exclusive and may be compounded in a language like Georgian, leading to initial clusters of excessive complexity (cf. Nepveu 1994, Bush 1997, Vogt 1958).

With respect to rhymal structure we can make similar observations. Languages such as Dutch, English, and Hungarian (where in Hungarian accent marks indicate length) allow word-final 'rhymes' that are rather complex:

	Dutch		*English*	*Hungarian*	
(6)	oogst	'harvest'	sixth	társ	'companion'
	ernst	'seriousness'	blast	meggy	'sour cherry'
	vreemd	'strange'	clown	fűt	'to heat'

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 dialects (cf. chapter 16, this volume). In addition, there are phonological alternations which suggest that in certain languages long vowels cannot occur in a closed syllable word-internally. Kaye (1990) cites such evidence from Wolof:

	Imperfective	*Inversive*	
(7)	rɔɔf	rɔppi	'to put in/to take out'
	yɛɛw	yɛwwi	'to tie/to untie'
	tɛɛʀ	tɛddi	'to start/to stop a vehicle'

Such effects, often called *Closed Syllable Shortening* (CSS), are found in many languages suggesting that rhymes are maximally binary (i.e. bi-positional), consisting of a short vowel plus consonant or a long vowel by itself. The occurrence of complex rhymes at the right edge of words again has lead to postulating concepts like 'extrasyllabic consonants', 'heterosyllabic representations of long vowels', 'appendices', 'stray onsets', or onsets followed by 'empty rhymes'.

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. chapter 6 for a discussion of this domain which is called 'non-analytic' in government phonology; cf. Kaye (1995).[6]

Some languages, however, seem to challenge the claim that certain complexities occur at edges only, by allowing words to consist of sequences of consonants only:

(8) *Nuxalk* (formerly called Bella Coola; Baghemil (1991)
xsćc 'I'm now fat'
lxwtlcxw 'you spat on me'

Imdlawn Tashlhiyt Berber (Dell & Elmedlaoui 1985)
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 (S. Newman 1969, 1971), that there is only partial syllable structure (Baghemil 1991), or that syllables have obstruents as their peaks (Hoard 1978). Dell & Elmedlaoui (1985) suggest that in the Berber dialect that they analyze any type of segment (including all consonants) can form a syllable peak. An alternative analysis of similar facts in another dialect can be found in Guerssel (1990), who postulates empty nuclei.[7] The point of these examples is to suggest, however, that apart from complexities regarding consonant clusters at edges, the total absence of vowels throughout a word is a phenomenon that we must also reckon with. Unfortunately, the present volume does not contain a chapter dealing with any of the last type of languages and an insightful analysis of most of such cases, embedded in a principled theory of syllable structure, is not known to us.

As a final remark in this section, we draw attention to the fact that especially in the latter type of cases (but also in the languages with complexities at edges only), we have to take into account the morphological composition of words. This issue relates closely to determining the precise domain of the syllabic organization in terms of which we capture the phonotactic patterns of a language.

3. The syllable as a phonological unit

3.1. Reintroducing the syllable[8]

The, by now, traditional manner of motivating the need for the syllable in phonological analysis is to memorize the position that Chomsky and Halle took in their *Sound Pattern of English* (1968) (SPE). Assuming that the best theory of phonological representations is the most minimal one, Chomsky and Halle proposed that a phonological representation is simply a string of unordered feature bundles, provided with a set of boundary symbols reflecting the morphological composition of words and a labeled bracketing system representing the syntactic organization of these words. It soon became clear that 'doing phonology without syllables' was a mistake. The representations were perhaps simpler by not containing yet another type of boundary (i.e. syllable boundaries), but the rules (i.e. those which in fact depended on the syllabic organization) turned out to be more cumbersome than necessary, in particular because each of them in some sense encoded the principles for locating the syllable boundaries. The two rules in (9), symbolizing a phonological process 'A changes to B in the environment ...', reconstruct the notion of open and closed syllables, respectively, in the description of the environment:

(9) a. $A \rightarrow B \ / \ \_\_ \ \{\#, CV\}$
b. $A \rightarrow B \ / \ \_\_ \ C \ \{\#, C\}$

The context '__ CC' in (9b) would in fact have to be further characterized (in a further condition to be added to the rule) as not referring to sequences of an obstruent followed by a sonorant liquid in languages where such clusters are allowed as well-formed onsets. Clearly, identifying syllable boundaries before applying rules is a necessary tool. The representation may get more complicated by adding syllable boundaries or syllable structure, but the rules can be simplified and, more importantly, freed from arbitrary disjunctions like 'either a word boundary or a consonant'. By applying syllabification first, the explanation for why these two contexts form a natural class becomes more apparent.

Subsequently, additional arguments have arisen in which it has been pointed out that rules or generalizations not only refer to syllable edges, but also to the syllable itself as a domain. Certain languages show that features (nasality, for example) may take the syllable as their domain; cf. Nespor & Vogel (1986: chapter 3), and van der Hulst & Smith (1982). A third argument that has been brought forward in favor of the syllable has been that this unit (or one of its constituents, the rhyme or the mora(s)), rather than the vowel, may be the bearer of such 'suprasegmental properties' as accent or (lexical) tone. In this

case, even though it is not the syllable but a proper subpart of it (its rhyme or moras), that is the actual bearer of such properties, it was still assumed that it is necessary that the unit of which these entities form a part must be represented in some fashion.[9] Arguments regarding accent have especially supported recognizing the syllable (or a part of it) as a crucial level in the so-called prosodic hierarchy; cf. Nespor & Vogel (1986).

Finally, the syllable appears to have another kind of motivation involving the notion of well-formedness. In SPE, regularities in the shape of lexical entries (formatives or morphemes) were encoded in so-called morpheme structure rules or constraints. Among these, we find (i) segment structure constraints which define the combinations of specified features that define the class of segments in a language, and (ii) sequence structure constraints which define well-formed sequences of segments in a language. In English, for example, a well-known sequence constraint marks morpheme-initial /bn/ as ill-formed, while allowing /bl/, /br/ etc. Once syllables were recognized, such statements seemed more adequately stated in terms of this type of unit; cf. Clayton (1976), Shibatani (1973), and Hooper (1976). The question concerning at what level such syllable structure constraints are stated (underlying, surface) is discussed in section 4.

In summarizing, below are the five major arguments advanced in support of the adoption of syllable structure:

(10) a. Reference to the edges of syllables
b. Reference to the syllable as a domain of feature 'spreading'
c. Reference to the syllable (or part of it) as the anchor of suprasegmental features
d. Reference to the syllable as part of a prosodic hierarchy
e. Reference to the syllable as the domain of well-formedness constraints

McCawley (1968), Fudge (1969), Hoard (1971), Vennemann (1972), Shibatani (1973), Anderson & Jones (1974), Clayton (1976), and Hooper (1976) were among the first generative phonologists to return to the syllable, often using a boundary approach. Fudge (1969) and Kahn (1976) introduced a hierarchical view of the syllable, which fit better with the emerging hierarchical theories of phonology (Rotenberg 1978, Liberman & Prince 1977, Selkirk 1980). Shibatani (1973), Clayton (1976), and Hooper (1976) also argued specifically for the syllable as the unit of phonotactic constraints.

With the rise of hierarchical structure (involving not only syllable structure but also higher prosodic structure) and the autosegmental deconstruction of the segment in terms of a hierarchy of feature tiers, the laudable minimalistic approach of SPE with respect to the structure of phonological representations was replaced by a view on representations which favored a rich and elaborate

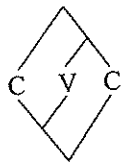
structure. In autosegmental phonology, the string of segments (as feature bundles) was replaced by a string of abstract place holders or skeletal points which formed the anchor points for features or feature classes on one hand while also being the starting point for a hierarchical organization into syllables, and further into feet, prosodic words, clitic groups, all the way up to phonological phrases, intonational phrases, and the utterance (cf. Nespor & Vogel 1986). The representational richness was (programmatically) counterbalanced by the expectation that the rules would become more constrained, both in terms of what they could do (hopefully only 'natural processes') and how they would do it (only in terms of elementary operations of inserting and deleting association lines). This development was driven by the idea that if the representations are right, the rules will follow. If taken literally, this means that languages will ultimately only differ in their representations, a view that requires a system of parameters with settings that determine limited options with respect to every hierarchical level of representation. Explicit systems of parameters have been proposed for the levels directly above the syllable, viz. the foot and word level (in the context of the 'metrical theory' of stress; cf. Vergnaud & Halle 1978, Halle & Vergnaud 1987, Hayes 1980, 1995, van der Hulst 1999b). Limiting ourselves in this chapter to the level of syllable structure, we will not discuss these metrical parameters. Instead, we will turn to parametric theories of the syllable in the next section.

3.2. Different views on the syllable-internal organization

After having briefly summarized why the syllable was re-introduced into generative phonology, we proceed with discussing some of the different views on its internal structure. Early theories which referred to boundaries as well as Kahn's (1976) flat 'autosegmental' theory claimed no internal structure for the syllable, presumably since the focus at that point was on the division of the segmental string into syllabic units and/or on the segmental processes which make reference to syllable edges.

With respect to theories that assume internal structure we usually distinguish between two major types (cf. Ohala, this volume):

(11) a.



b.

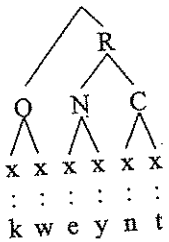
Vennemann (1984) referred to (11a) as the head-body structure and to (11b) as the body-tail structure, arguing that the proper choice is dependent on the process that one studies. In section 4, we will return to this viewpoint which implies that both structures are in some sense available. First, we will discuss both structure types in terms of some of their current-day instantiations.

3.2.1. *Onset-rhyme models*

The head-body or *onset-rhyme* model can be traced back to traditions in Chinese phonology (cf. Duanmu, this volume). It can also be found in numerous phonological works produced in the twentieth century, either informally or explicitly worked out in various ways (cf. Fischer-Jørgensen 1975, Anderson 1981; an historical overview of the concept syllable before generative phonology can be found in Adewyck 1975). Fudge (1969, 1987) analyzes English syllable structure in terms of an onset-rhyme model, allowing both constituents to contain subconstituents of various kinds; Selkirk (1982) follows this approach, adopting some of the, by then, available non-linear machinery. Before that, McCarthy (1979) had employed this type of model in his study of Arabic phonology. Onset-rhyme theories can also be found in Cairns & Feinstein (1982), Lapointe & Feinstein (1982) and in government phonology (cf. below).

In most general terms, a hierarchical onset-rhyme model organizes a string like English /kweynt/ 'quaint' in the following way:

(12)

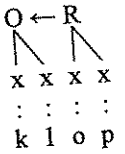


(Where the alphabetic symbols k, w, e, y, n, t abbreviate a hierarchical structure of tiers with features.)

The terminals in this model are formed by the skeletal points (represented with x's), the anchor point for root nodes or phonological features. The structure in (12) represents a syllable with a branching onset and a branching rhyme, where the latter constituent dominates two further branching constituents: the nucleus and the coda. Some proponents of this structure would claim that all these subsyllabic constituents are headed by the left-hand skeletal point. 'Headed' in some sense means that the stronger, salient position is qualitatively more closely representative of the constituent itself. Government phonology, an approach that can be traced back to Kaye & Lowenstamm (1984), defends a version of this view explicitly.

In Kaye, Lowenstamm & Vergnaud (1990), the syllable is no longer recognized as a constituent, however. We refer to the contributions in part II of this volume, and specifically to chapters 6 and 7 for a discussion of this point. Yet, even though the syllable is not recognized as a constituent, it is argued by KLV that the O(nset) and R(hyme) form an inseparable 'package' where the R 'governs' the O. This makes the nucleus the head of the 'syllable package', a claim also advanced in Levin (1985). Government phonology captures the special character of the onset-rhyme liaison by postulating a 'government relation' which does not correlate with a sisterhood relation, as shown in the GP representation of the Dutch word *klop* 'knock':[10]

(13)



(The vertical constituent lines indicate headedness within constituents; the arrow indicates 'government' between the two syllabic constituents.)

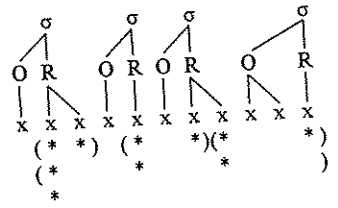
We believe that the denial of the syllable as such is an interesting viewpoint, which we elaborate on in chapter 6 (this volume). Harris (1994) and Brockhaus (this volume) point out that rules and constraints that have been claimed to refer to the syllable can also be stated with reference to the onset or rhyme. Another essential observation that we advance to support the idea that the O and R somehow do not form a constituent in the phonological hierarchy is that onsets do not contribute to 'syllable weight' (cf. P. Newman 1972). This observation remains unexplained if feet are claimed to be built upon syllables, which would, in addition, entail that the computation of weight is non-local in skipping the syllable-level.[11]

In addition, viewing the onset-rhyme package as a syllable constituent does not fit conceptually into the general structure of the prosodic hierarchy which at all levels (except the syllabic one) seems to group units of the *same type*: syllables into feet, feet into words, words into phrases etc. (cf. van der Hulst 1984, Nespor & Vogel 1986).

To avoid building the onset-rhyme package into the prosodic hierarchy, one might also follow the line of Halle & Vergnaud (1987), who build hierarchical structure on a separate plane which does not contain syllables, but rather a projection of only the stress-bearing units. This plane, like the syllable, uses the skeletal positions as starting points.[12] This approach makes a crucial prediction,

viz. that feet (represented by bracketing the lines that contain the stress-bearing units) can group stress-bearing units that belong to different rhymes. This possibility is displayed in (14) in which the third rhyme, since it is branching, contributes its stress bearers to both the second and third foot:

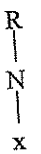
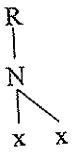
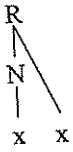
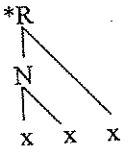
(14)



(line 0): stress bearing units/moras
(line 1): heads of feet/secondary stress
(line 2): head of word/primary stress

We believe that this view is not correct, but a discussion at this point would take us too far afield from the focus of this chapter. What we essentially claim for such cases is that the 'surface syllables' that are claimed to be split up between feet are really syllable (or rather rhyme) sequences at the level of representation that is relevant for the computation of stress. In general, we should be aware of the fact that an apparent long vowel or diphthong may be a sequence of two nuclei with hiatus in between. Such analyses are common in government phonology; cf. Yoshida (1990) on Japanese, Ritter (1995) on Hungarian; cf. chapter 6, this volume, section 2.2.1.6.

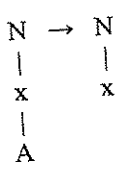
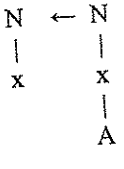
Returning to the head-body government phonology approach, we note that a further constituent has been postulated, viz. the nucleus, a constituent which also appears in earlier work on syllable structure (cf. 12). The coda, also widely occurring in head-body theories, is, however, not recognized as a constituent in government phonology, although the nucleus node may have an 'adjunct' (cf. 15c). The nucleus is the head daughter of the rhyme. This potentially generates the four rhyme structures in (15):

(15) a. 
b. 
c. 
d. 

The difference between (15b) and (15c) is that (15c) ends in a 'coda' position that must be occupied by a consonant. By treating the coda position as a skeletal point which is directly dominated by the rhymal node, rather than as an autonomous sub-syllabic constituent, government phonology denies the option of a 'branching coda'. An additional principle (called 'coda licensing' in Kaye 1990) determines that coda consonants must be licensed (which means that their existence is only possible when 'followed') by an onset and, additionally, that, in that case, the coda consonant must be 'more sonorous' (or not more complex) than the onset consonant following.[13] 'Codas', as post-nuclear adjuncts, then, cannot occur word-finally. These issues are further discussed in chapters 6 (especially section 2.2.1.3) and 7 in this volume.

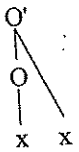
Given that nuclei can branch and that there is a coda adjunct, one might expect that the structure in (15d) is well-formed in the GP approach. Government phonology does not, however, admit (15d) on the grounds that constituents contain maximally two daughters[14] and in (15d) the rhymal constituent is a ternary structure. We will return in section 3.2.3 to the issue of representing 'superheavy' syllables which seem to involve rhymes such as VVC, VCC or even VVCC or VCCC, all excluded in the government phonology approach.

Government phonology allows the further option of (15a) to occur without content (i.e. an empty nucleus). To avoid the unlimited distribution of silent empty nuclei, GP stipulates that a silent, empty nucleus must be governed by a flanking full or audible nucleus in order to be allowed to remain phonetically uninterpreted. This context creates a (either trochaic or iambic) 'foot-like' dependency structure between the full and the empty nucleus.[15]

(16) a. 
b. 

Allowing 'degenerate syllables', however, is not the exclusive right of government phonology, as we have seen above. Both Kuryłowicz (1952) and Hockett (1955) allow syllables that consist of onsets only. These approaches, unlike GP, make no attempt to limit the distribution of onset-only syllables. In recent moraic approaches, we also find syllable-less moras (Baghemil 1991), headless syllables (Nepveu 1994) or moraless syllables (Shaw 1993). These models, too, suffer from the fact that no clear restrictions on the distribution of these objects are given. We refer to chapters 6 and 7 for further discussion of the dependency relations which control the distribution of empty nuclei.

We now turn to the onset. The axiom of binary branchingness adopted in government phonology also allows just a limited array of options for the onset:

(17) a. 
b. 
c. 

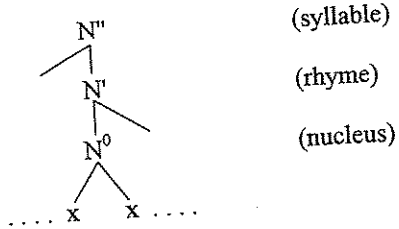
In fact, government phonology only recognizes (17a) and (17b). The structure in (17a) can appear empty, i.e. without a consonant filling it. Such empty onsets 'act like' consonants, for example in triggering vowel-final allomorphs of articles which would only normally precede a word that starts with a consonant (cf. the so-called h-aspiré cases in French) or in blocking the coalescence of nuclei (e.g. in Turkish words that show the effect of '/g/-deletion'); cf. chapter 6, section 2.2.1.1, this volume, and Clements & Keyser (1983) who account for such effects in a similar fashion.

Since government phonology assumes that every rhyme is preceded by an onset, even in the absence of an overt consonant or the above-mentioned effects, the model also postulates a 'pointless' O, i.e. an onset that does not have an x-slot and effectively has no phonological function. Such a pointless onset plays no role in the phonology and could just as well be omitted. In chapter 6, section 2.4.4, we discuss whether the distribution of empty onsets is also controlled in terms of government relations.

The logical option of allowing onsets that have an additional projection level (cf. 17c) is neither principally excluded nor explicitly discussed in any government phonology work that we are aware of. Yet this possible option forms a formal analogy to the coda structure in (15c). In fact, additional structures are also possible in which branching is found at both bar-levels such that the dependents occur on different sides of the head.[16] It would perhaps be a possible structure with a left-adjoined position for 'fake' onset clusters, like the ones we discussed in section 2, (3a), but we leave a further discussion of this idea for another occasion.[17]

Let us now take a look at another proponent of the head-body[18] approach to syllable structure, i.e. Levin (1985) (adopted by Calabrese in chapter 22 of this volume, and elaborated upon by Smith in chapter 19 of this volume) who regards the syllable as the projection of its nucleus:

(18)



(syllable)

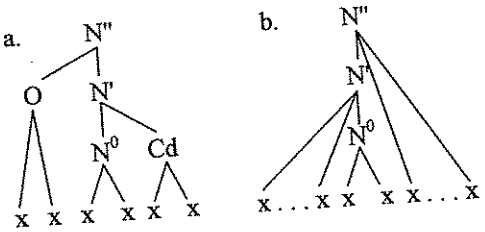
(rhyme)

(nucleus)

This model builds on the idea that the syllable is a headed constituent showing some kind of X-bar like structure in which the coda and onset form the complement and specifier, respectively; cf. Ritter (1995) for a similar position. Like an onset-rhyme model, this model must also stipulate that only material adjoined to N^0 is potentially weight-determining.

Regarding the representation of onset and coda material, this X-bar model can be worked out in various ways. One view is to recognize an onset and coda constituent, allowing both to branch. The other view is to allow multiple adjunctions directly to the N' and N'' levels:

(19)



The difference between the two views regards the possibility of making claims about the complexity of the syllabic margins. The view embodied in (19b) effectively denies the existence of onsets and coda *as constituents* and is therefore unsuited to formally restrict the complexity of margins. Placing restrictions on adjunction itself (for example, stipulating that adjunction applies only once per X-bar level) seems unprincipled or leads to incorrect results (if onsets can be more complex than codas). Thus, a theory such as (19b) can only place restrictions on the complexity of nuclei (e.g. requiring them to be binary). The view in (19a) approximates that of government phonology, but is less restricted in recognizing a branching coda constituent, and in allowing the combination of branching nuclei and branching rhymes (leading to superheavy syllables). An additional property of government phonology, which is not incompatible with the views in (19) and could thus be added to it, is that all the syllabic constituents are themselves headed.

The choices between the various OR models that we have discussed depend in part on general *views* regarding the kinds of cognitive structures that one wishes to recognize in linguistic theories. If one believes that the principles underlying the syntax of linguistic expressions generalize over the morphosyntactic and phonological modules of grammar (the *Structural Analogy Hypothesis* proposed in Anderson & Ewen 1987), then findings in syntactic theory lead to expectations, and limitations, regarding the kinds of models that one wishes to consider for phonology, and the other way around. *Dependency Phonology* (Anderson & Jones 1974, Anderson & Ewen 1987) and government phonology explicitly adopt this position.

On the other hand, one can also look at the various options from the viewpoint of trying to find the most adequate analysis of the phonological *facts*, disregarding the structural analogy hypothesis and adopting the 'phonology is different' position (Bromberger & Halle 1989), which we regard as a very

narrow interpretation of the modularity idea, i.e. the interpretation that the formal architecture of different modules *must* be different.

We conclude this section with a discussion of the various ways in which models deal with very complex consonant clusters. Two extreme views can be found. One extreme has already been considered, viz. (19b). No formal restrictions are placed on the complexity of syllable margins. Unlimited adjunction can accommodate all complexities. Within *Optimality Theory* (Prince and Smolensky 1993), this seems to be the prevailing idea (cf. Bush 1997 on Georgian). The 'markedness' of complex structures is expressed by the fact that these structures violate prosodic constraints that demand simplicity and that outrank 'faithfulness' to the underlying or lexical input.

Toward the other end of the spectrum we find the theory of government phonology, as outlined above. Essentially this theory claims that a 'syllable', or O-R package, can maximally accommodate strings like /kloo/ or /klop/ with the latter O-R grouping being restricted to word-internal position only, due to the principle of coda licensing (Kaye 1990). In this view, then, English clusters like /spr/, let alone /brgn/ in Polish or /prckvn/ in Georgian, cannot form complex onsets, while sequences consisting of a long vowel and one or two consonants (VVC, VVCC), or short vowel and two consonants (VCC) cannot be complex rhymes. The question then arises as to what kinds of structures these really are and how they can be represented. Proposing the syllabic constituents in (15a,b,c) and (17a,b) as an exhaustive list, leaves only one answer. These complex clusters and superheavy 'rhymes' must consist of more OR packages than one might at first realize when attending to the surface facts. In addition, some of these OR-packages must contain onsets or nuclei that have no segmental content. In short, the explanatory device of government phonology is to allow structural units that are phonologically relevant but have no phonetic interpretation. It stands to reason that this approach is, therefore, committed to constraining the contexts in which such silent units can occur and, resultantly, their possible proliferation as well. We refer to the chapters in part II of this volume for a discussion of the methods by which silent units are kept in check. In evaluating the markedness of structure it only matters whether parameters have been set on marked or unmarked values.

In placing GP on one end of the scale of restrictiveness, we find both less and more restrictive models surrounding this approach. Somewhat *less* restrictive are approaches found in Fudge (1969), Cairns & Feinstein (1982), and Lapointe & Feinstein (1982) which allow onsets to have 'specifiers' (notably to accommodate /s/), rhymes such as (15d) and, in addition, appendices of various sorts. *More* restrictive than standard government phonology is the theory proposed in Lowenstamm (1996) and Scheer (1996, 1998), which argues that both onsets and rhymes are unary constituents, essentially arriving at CV as the maximal syllable template. CV is also the minimal template since Lowenstamm assumes, with standard government phonology, that the onset and the rhyme always come in a package. The distinction between a nucleus and rhyme unit disappears in this strict CV approach, and so does the distinction between syllabic constituents and x-slots. Lowenstamm's typology of syllabic constituents therefore reduces to the possibilities in (20):

(20) a. C
|
p

b. V
|
a

c. C

d. V

It stands to reason that Lowenstamm's *Strict CV model* proliferates the number of empty nuclei, and, to a lesser extent, the number of empty onsets. Standard government phonology sometimes analyzes a language as strictly CV while the surface facts seem to indicate otherwise (cf. supra), but Lowenstamm would also postulate empty nuclei where standard government phonology would analyze 'well-behaved' branching onsets or coda-onset sequences. Scheer (1996) points out that the proliferation of empty nuclei leads to simplification in the theory of proper government. Chapter 11 (this volume) adopts the strict CV approach.

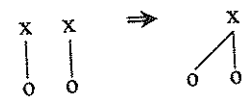
Anticipating the discussion in the following section, one might characterize the strict CV theory as a theory that makes no distinction between the unit syllable and the unit mora in that every CV unit is per definition a mora.

3.2.2. *Mora-models*

Turning our attention now to the body-tail structure in (11b), in this section we discuss an approach that has come to be known as mora theory. Although the term mora has a longer history (e.g. Trubetzkoy 1939), even in generative phonology (e.g. McCawley 1968), the *hierarchical* moraic model was introduced in Hyman (1985), based on a manuscript from 1983. Its major impact has been on the treatment of compensatory lengthening; cf. Hock (1986) and Hayes (1989).

Hyman starts out by proposing that x-slots are in fact mora slots which he refers to as 'weight units'. The weight-irrelevance of onsets is explained by universally delinking onset segments ('root nodes') from their skeletal point and adjoining them instead to a moraic slot:

(21)

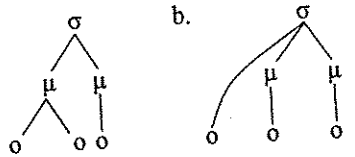


weight/mora tier

root tier

In later versions of moraic theory (cf. Hayes 1989) a somewhat different conception emerged in that the x-tier was simply replaced by the mora tier in all cases. In one version of that approach, the idea was then also given up that onset material be dominated by the mora which constitutes the syllable peak vowel (as in 22a). Instead, in Hayes (1989), the onset material links directly to the syllable node (as in 22b). Thus two different moraic theories emerge:

(22) a. b.



Version (22a) is used in Bird (this volume) and Hyman & Katamba (this volume). The version in (22b) is no longer a pure representative of the body-tail approach. It, in fact, comes very close to the head-body approach, differing from it mainly in not representing onset material as a constituent.

Both versions of mora theory share the idea that the onset constituent as such does not exist. In (22a) all prevocalic consonants are tucked under the first mora. In (22b) all prevocalic consonants are directly adjoined to the syllable node without an intervening onset node. This means that in both models no restrictions can be placed on the complexity of 'onset' clusters. With respect to final non-moraic consonants, both models differ in an analogous manner.

3.2.3. A comparison of OR and moraic models

Having outlined the OR and moraic approaches to the syllable, let us address some of the arguments that have been put forward in favor of the moraic approach. The moraic approach has been claimed superior with respect to a number of issues:

(23) a. Forming part of the prosodic hierarchy
b. Explaining the weight-irrelevance of the onset
c. Expressing the variable nature of coda-weight
d. Treating (light) long vowels and geminates
e. Treating superheavy syllables
f. Treating compensatory lengthening

a. Forming part of the prosodic hierarchy
It has sometimes been argued that the moraic theory fits better within the prosodic hierarchy which seems to always organize units of the same type (van der Hulst 1984, Nespor & Vogel 1986), i.e. words contain feet, feet contain syllables, but syllables contain the unlike units onset and rhyme. In addition, if syllables with an OR structure are seen as part of the prosodic hierarchy, the problem arises (mentioned above) that the branching properties of the syllable itself must be ignored when weight is computed. The moraic theory does not have these problems. Actually, this is only true for moraic theory as construed in (22a) and not for the more popular version in (22b). Assuming the representation in (22a) means that the syllable contains like units (i.e. moras) and, in computing weight, the branching properties of syllables are directly relevant.

In the OR-theory, however, given that only the R-part is considered to be part of, or projected to the prosodic hierarchy, the lowest level in this hierarchy, in fact, organizes units of the same type, i.e. x-positions, just like the higher levels; cf. chapter 6, section 2.2.1.2.

b. Explaining the weight-irrelevance of the onset
It is sometimes claimed that mora-theory explains why onset material is weight-irrelevant because prevocalic consonants cannot be moraic. But it seems to us that the non-moraicity of the prevocalic consonants is entirely stipulative. In OR-models, the weight-irrelevance of onset consonants is derived by placing the onset outside the prosodic hierarchy; cf. point (a) above. Both moraic and OR-models, thus, in some sense stipulate that only a certain part of the syllable is relevant to the prosodic hierarchy. The OR-theory, however, in claiming that the R-part is the relevant part, connects the onset-irrelevance to the well-established phonotactic independence of the onset and the rhyme; cf. below.

c. Expressing the variable nature of coda-weight
In moraic theory, the approach to distinguishing weight differences is that short vowels project one mora whereas long vowels are necessarily bimoraic and thus weightier or heavier. Moraic theory conflates length and weight due to the elimination of the x-tier.[19]

Whether consonants contribute to weight depends on their position (i.e. weight-by-position). In the onset they never do, while in the coda they can, depending on the language.[20] If codas are weightless, they are non-moraic and are directly adjoined to the syllable node (assuming the model in 22b):

(24)

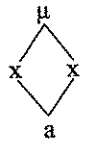
If only a subset of the possible post-vocalic consonants in a language contributes to weight, weight-by-position would be made sensitive to the featural content of the coda-consonants by specifying some kind of sonority threshold for moraicity, a situation claimed to exist in Kwakiutl (cf. Bach 1975). This approach is discussed in van der Hulst (1984), following the manuscript version of Prince (1983) (cf. also Zec 1995a, 1995b).

The question arises whether the variable weight of codas can be captured in OR-models which lack specific organizing weight units such as the mora. It would seem to us that the function of the branching ability of the rhymal constituent can be construed to subsume the notion of coda weight without making reference to specific moraic weight-bearing units of structure. First, for example, if in a language the lower nucleic projection is construed to count in interpreting weight, then branching in this lower projection will predict that all long vowels in this language are construed as heavy while syllables closed by a consonant, which require branching at the higher rhymal projection, will not count as heavy since this higher-up projection is not considered to contribute to the interpretation of weight. Thus a distinction can be made between syllables that are heavy (i.e. having long vowels) versus those that are light (i.e. having short vowels). However, if a language parametrically chooses the higher-level rhymal projection as the projection at which weight is construed, then the occurrence of branching within the rhyme, i.e. the presence of two positions, signals that a heavy weight effect exists. In this way, a long vowel and a closed syllable can be deemed to pattern in a similar manner given that it is the mere existence of having two positions within the rhyme that signals heaviness. For cases in which only a subset of the consonants (i.e. the sonorants) contribute to weight, it would be necessary to adopt the threshold approach discussed above.[21]

d. Treating (light) long vowels & geminates

As formulated above, neither the mora-approach nor the OR-approaches allow a situation in which closed syllables are heavy while open syllables with long vowels are light. This is a suspect option, even though it has been claimed to apply in Dutch. Lahiri & Koreman (1988) address this issue and propose that Dutch 'tense' vowels are long but light, light meaning monomoraic. They propose to represent this in terms of reintroducing the skeletal tier:

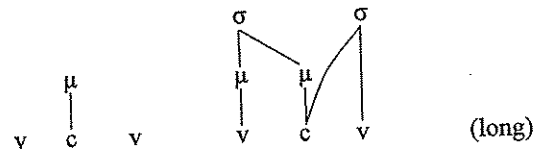
(25) Dutch long light vowels



An alternative analysis (proposed in van Oostendorp 1995) is to argue that the Dutch tense vowels are actually short. Since lax vowels must always be followed by a consonant, it suffices to say that stress is sensitive to a distinction between open (light) and closed (heavy) syllables.

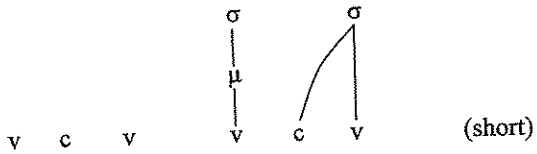
Lahiri & Koreman (1988) not only discuss the issue of light long vowels, but also the moraic status (and weight) of left-hand sides of geminates. Mora theory derives geminates from intervocalic consonants that are lexically moraic. In (26) we depict the manner in which, in moraic theory, long consonants and short consonants are derived. In (26a) we have an underlying, moraic consonant which subsequently gets linked both as a coda to the first syllable and as an onset to the second syllable. In (26b), we have an underlying, non-moraic consonant which only gets linked as an onset to the second syllable:

(26) a.



(long)

b.



(short)

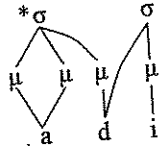
Thus, a long consonant entails bimoraicity of the preceding syllable. It has been pointed out (Lahiri & Koreman 1988, Selkirk 1990, Tranel 1991, Davis 1999) that this representation of geminates predicts that geminates necessarily produce heavy closed syllables. Thus, if a language has weight-sensitive stress rules, but lacks the rule of weight-by-position (proposed in Hayes 1989) which assigns a mora to a coda consonant, the approach predicts that syllables closed by a geminate will nonetheless be heavy. Tranel (1991) cites several examples which show that this actual phenomenon is not borne out and he proposes, like Lahiri & Koreman (1988), to restore the skeleton in addition to admitting the

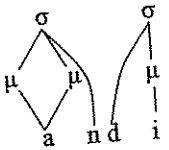
mora level.[22] Davis (1999) produces evidence in favor of the inherent weight of geminates which we discuss immediately below.

e. Treating superheavy syllables

Various versions of mora theory can be found specifically concerning the maximal complexity of the 'rhymal part of the syllable'. While van der Hulst (1984) and Hayes (1989) consider tri-moraic syllables (for superheavy rhymes), others have proposed an upper bound of two moras, thus adopting, in mora theory, the essential binarity principle of government phonology.

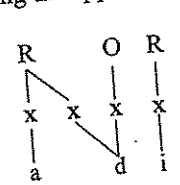
Davis (1999) presents an argument for the moraic approach to geminates which is based on the claim that syllables are maximally bimoraic. Referring to Sherer (1994), Davis points to cases in which VVC sequences behave differently from VVG sequences (where G indicates the left-half of a geminate). In Koya (Dravidian), word-internal VVC occurs but VVG does not. A similar pattern occurs in Hindi (PIE, Indo-Aryan). Additionally, Sherer (1994) refers to languages that have VVC, while potentially occurring VVG sequences (syllables) trigger shortening to VG. How can we explain this asymmetry between VVC and VVG? The explanation, according to Davis, adopting a moraic approach, is that in a model in which geminates are inherently moraic and long vowels are bimoraic, long vowels preceding a geminate would result in a trimoraic syllable, as in (27a). In the languages mentioned, weight-by-position is absent. From these assumptions it follows that VVC, as in (27b), is bimoraic:

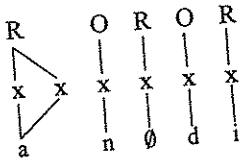
(27) a. 

b. 

The languages that allow (27b) while disallowing (27a) simply disallow trimoraic syllables.

Can the same asymmetry be accounted for in government phonology?[23] An answer to this question depends on how, in GP, long vowels will be represented. This issue is discussed in chapter 6, section 2.2.16. For the sake of the argument, we will assume here that long vowels are represented as branching nuclei. We will also assume that geminates in the relevant languages are represented as coda-onset sequences, with the consonant occurring in onset and 'spreading leftward' into the coda.[24] GP predicts that long vowels cannot occur before any type of coda consonant, because ternary rhymes are excluded (cf. 15d), thus ruling out both VVC and VVG as rhymes. The possibility can be explored, however, of analyzing the alleged closing consonants in a VVC sequence as an onset followed by an empty nucleus. Assuming, then, that this option exists in the languages at issue, we can arrive at the following representations. In (28a) we see that true geminates can only be preceded by a short vowel. (28b) shows that a long vowel can be followed by an empty-headed syllable, giving the appearance of a VVC rhyme:

(28) a. 

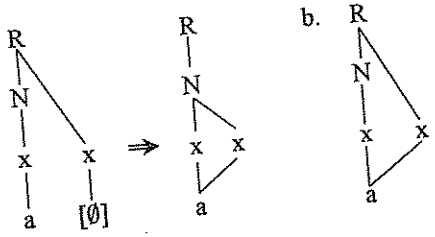
b. 

f. Treating compensatory lengthening[25]

Mora theory treats compensatory lengthening (CL) by assuming that the loss of a postvocalic consonant entails the stability of its mora to which the vowel melody then subsequently spreads. Since onset material is always non-moraic, loss of onset consonants never entails CL.

By positing a distinction between onsets and rhymes as separate constituents, in the sense of their being separate maximal projections, government phonology is also able to capture the prediction that mora theory makes regarding the fact that onsets do not participate in compensatory lengthening processes. In government phonology the claim could be made that the lost segments and the lengthening segment must belong to the same constituent, namely the rhymal constituent, and that loss of a segment in one maximal constituent cannot trigger lengthening from a separate and independent constituent. Furthermore, to understand (but not really explain) the absence of compensatory lengthening effects within onsets, it seems reasonable to appeal to the optional nature of the non-obligatory structural presence of an onset, which predicts that a process would not be required to save an onset position if segmental loss occurred. Note that onsets never or rarely contain geminates to begin with.[26]

In terms of representations, a problem might arise in OR approaches if it is assumed that the loss of a consonant in coda position cannot without additional machinery (e.g. reorganization within the constituent) lead to the emergence of a long vowel:

(29) a. 

b.

This problem is addressed in Ritter & Vago (1999), where it is argued that there is no reason why (29b) could not be the outcome of compensatory lengthening, although, admittedly, independent evidence must be found for allowing this extra manner of representing long vowels.

The whole problem does not arise if one adopts a version of OR theory that makes no distinction between rhyme and nucleus. cf. section 2.2.1.5, chapter 6, this volume. There it is also argued that long vowels should perhaps always be represented as bi-nuclear. This would cause no problem if the consonants prior to disappearing are, in fact, onsets, followed by an empty nucleus, rather than codas. If, then, long vowels are always bi-nuclear, we can derive the fact that branching onsets cannot contain geminates from the general claim that no syllabic constituent (whether onset or nucleus) can contain long segments.

Conclusions

The above discussion does not support the claim that mora theory is superior to OR theory. In fact, our own conclusion would be that the reverse applies.

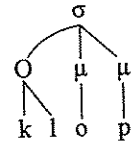
While GP theory seems to be able to capture the same insights as moraic theory, GP theory surpasses moraic theory in that GP theory can better account for phonotactics and in connecting the phonotactic independence of the onset to its irrelevance in the prosodic hierarchy; cf. Zec (1995b) on mora theory and phonotactics.

It has been pointed out in many studies on phonotactics that the set of core syllables consists of almost every combination of well-formed onsets and well-formed rhymes. Some combinations are sometimes excluded (cf. Clements & Keyser 1983 for examples from English), but these cannot seriously be used as evidence against the strong phonotactic independence of onset and rhyme. Mora theory, not recognizing an onset constituent, cannot express the notion of onset well-formedness in a straightforward manner. In addition, there is no notion of unified rhyme either since the constituent status of post-vocalic consonants depends on their weight. This would predict a different phonotactic behavior of weightful and weightless consonants vis-à-vis the preceding vowel. We are not convinced that such differences can be empirically supported (despite the examples in section *e*, above).

3.3. Hybrid models

It is of course possible to invent all sorts of hybrid models, containing moras *and* an onset constituent. If such proposals would incorporate restrictions to the effect of only allowing bimoraic syllables and biconsonantal onsets, and if, in addition, one would add the idea that the left-hand mora is the head mora, it would seem that a moraic approach and the above-discussed government-based onset-rhyme approach become notational variants:

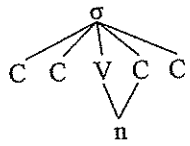
(30) a. 

b. 

In both types of models the claim is expressed that a certain portion of the syllable, viz. the rhyme or the moraic part, is prosodically active. The 'onset' portion is 'somehow' adjoined to this active part. Shaw (1993) argues in favor of another type of mixed model, adopting a nuclear rather than an onset constituent.

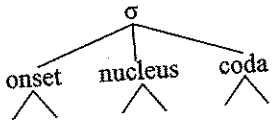
The main difference that remains between (30a) and (30b) regards the question of whether the onset is linked to skeletal points to which the segmental content (through a root node) is associated. It seems to us that neither way of looking at the potential complexity of the onset is fully satisfactory. The OR theory faces the problem of being unable to explain why onsets do not contain geminates (or allow CL)[27], while mora theory cannot express restrictions on the complexity of onset material. The solution, we believe, might come from the direction of theories that regard complex onsets as a special type of complex segment. Hirst (1985), Golston & van der Hulst (1999), Fujimura & Lovins (1978), Rennison (1997), and van der Hulst (1999a) represent just a selection of the works where this position has been investigated.

Many other types of hybrid models have been proposed. Clements & Keyser (1983) propose a flat model with an additional tier for a nucleus constituent:

(31) 

Our main objection to this model, however, is the absence of an onset constituent and thus the impossibility of making direct statements regarding the complexity of material that intervenes between successive nuclei. A further type of model is that found in Pike and Pike (1947) and Davis (1985):

(32)



Here the drawback is that there is no recognition of a rhymal unit. Presumably many more syllabic models can be and indeed have been proposed. The discussion in this section aimed at giving an idea of the kinds of models that seem to prevail in the literature and the kinds of arguments that have been submitted in their support or defense.

4. Optimality theory and levels of representation

4.1. Parameters versus constraints

So far we have been assuming an approach that characterizes syllable structure in terms of a set of principles and parameters which express what is common to all languages, allowing variation in terms of parametric choices. In accordance with government phonology, the universal schema is given by the OR package, parametrically allowing each syllabic constituent to contain zero, one or two segments. An additional set of licensing mechanisms limits the distribution of the zero-option. Optimality theory (OT; Prince & Smolensky 1993) replaces the parametric choices by ranked constraints. Invariant non-parametric aspects of syllabic structure (if there are any) are attributed to the Generator (which in this capacity embodies a theory of *possible* representations). If the generator is an unlimited device, invariant properties are expressed by a set of top-ranked constraints.

Constraints can be regarded as 'monovalent' parameters, expressing the unmarked setting. The equivalent in OT to setting a parameter to the marked state is to rank a constraint below another constraint which 'masks' its effect. In the least interesting case, the masking constraint is a monovalent version of the marked setting:

(33) a. Parameter Footheadedness: Foothead is Left/Right
b. OT equivalent: FootHeadLeft » FootHeadRight (or vice versa)

OT becomes more interesting when crucial constraint conflicts involve *independent* constraints, rather than 'opposite' constraints. There is as yet no clear view on the set of necessary constraints as OT is still in the stage of 'exploring its freedom'. Such explorations have a direct bearing on the observation that OT has been expanding the set of constraints very rapidly. Here we select two points for discussion that bear on the issue of syllable structure[28] and phonotactics and give a comparison of a parametric approach to a ranked constraint approach.

a. Richness of the output

The set of strings of segments that any particular language allows is filtered from the set of all possible strings of all possible segments by the ranked set of constraints.

The constraints that OT-phonologists tend to propose will be violated by segment sequences which are derived by the marked setting in a parametric approach, or which are strictly prohibited in the parametric approach.

For example: in the government phonology parametric approach, onsets are maximally binary. A string of segments starting with 4 consonants therefore *cannot* be parsed as an initial quadri-segmental onset. If a language contains words which start with four consonants, the theory predicts that this is only possible if the string can be parsed into a sequence of onsets separated by empty nuclei. Given that empty nuclei are not distributed freely, the theory makes certain predictions regarding the number of consonants that may seemingly occur in sequence. In addition, only certain types of consonants can be combined into a complex onset. Therefore, the theory makes additional claims about the nature of the consonants that form onsets or sequences of onsets.

Let us now compare this to the OT approach. In general terms, onsets consisting of more than one consonant in the input will violate a constraint that penalizes complexity, or perhaps a more specific constraint bearing on onsets (e.g. NoComplexOnset). Whatever constraint will do the work, the crucial difference with a parametric account will always be that no claim is made in OT regarding the upper limit in complexity that natural languages may display. A tri-consonantal onset simply violates the complexity constraint twice (if a so-called gradient approach to constraint violation is taken), and so on. Violations of the constraint occur in the output if this constraint is outranked by another constraint, IO-faithfulness, i.e. a constraint which penalizes any difference between the underlying input and the surface output form.

This approach cannot capture any cross-linguistic or language-particular regularities in, or constraints on complexity of segmental sequences because OT does not allow constraints on input. This is called 'richness of the base'. The constraints must filter out what is well-formed given any conceivable input. An obvious objection is thus that the OT account does not rule out the existence of languages that the parametric theory attempts to exclude. By allowing one of the conflicting constraints to be Faithfulness-to-the-Input, and given the assumption of Richness-of-the-base, no claims *can* be made

concerning the maximal complexity of output strings. If Faithfulness outranks Complexity any string of consonants is predicted to be part of the optimal candidate, provided that it is present in the input.

According to a principle of *Lexicon Optimization* (Prince & Smolensky 1993), language learners will not postulate inputs that could never surface unharmed. Lexicon optimization prevents the lexicon from containing arbitrary sequences of segments, which, given the constraint ranking would never reach the surface; as such it posits a constraint on abstractness of inputs. But this plausible principle in itself does not predict why languages with unlimited output segmental sequences do not seem to exist in the first place. In short, OT ranks languages on a scale of markedness or complexity but it does not rule out anything and, therefore, it does not characterize the notion of possible human language.

b. Emergence of the unmarked

A common objection to parametric models is that the setting of a parameter in some language excludes the possibility of the other setting in that same language once and for all (McCarthy & Prince 1995). We fail to see that this is necessarily the case.

If the onset-parameter is marked for allowing branching onsets, it does not follow that we have lost track of the fact that non-branching onsets are possible and, in fact, are the only ones that can occur in certain positions. It must be borne in mind that a theory of representations which incorporates head-dependency relations predicts that dependent positions favor simple and unmarked structures. Following Dresher & van der Hulst (1995, 1998) we may call this the head-dependent asymmetry principle (HDA-principle). Thus we predict that in a language that allows branching onsets, dependent syllables (in the foot) can be limited to containing non-branching onsets only. This approach explains emergence of the unmarked without appealing to language-specific constraint ordering, but instead by appealing to a universal dominance of the HDA-principle over parameter settings.

It has also been argued (e.g. in McCarthy & Prince 1995) that the setting of a coda-parameter to the marked option YES and the onset-parameter to the marked option NO (i.e. allowing onsetless syllables) fails to explain why a VCV string is always parsed V.CV. However, to explain this we only have to adopt a single inviolable and dominating principle which says that the least marked parsing is always the correct one. It seems to us that this 'markedness principle' has been implicit in all work on parameter theory.

In short, we conclude that OT, while remaining a *possible* framework for *expressing* analyses and generalizations, is not forced upon us because of any defect of parametric theories. Saying this we are aware of the necessity in the latter type of theory to appeal to universally top-ranked principles such as the HDA-principle and the 'markedness principle'.

4.2. Levels and derivationalism

In this section, we will briefly discuss some considerations that are relevant to determining at what level of representation syllable structure is represented. This issue is of course closely linked to the issue of how many levels are assumed to exist in the first place.[29]

In Chomsky & Halle (1968), a theory is proposed that allows an infinite number of levels, because phonological rules convert the *underlying level* to the *surface level* through the application of a series of extrinsically ordered rules. Extrinsic rule ordering creates *intermediate levels*, the number of which depends on how many extrinsic ordering stipulations there are.[30]

It seems that standard OT has inherited the derivational notion of making a distinction between input and output. There are no intermediate levels in OT.[31] Among others, this has led to the idea, at least in earlier versions of OT, that syllable structure is 'added' to the input strings (by the generator). This follows the earlier pre-OT view on syllabic structure as being predictable from the linear organization of the segmental string and thus 'derived'. It has never been shown, however, that this is a necessary way of looking at syllable structure and it seems only motivated by a metatheoretical principle of keeping the input (i.e. lexical representations) as simple as possible.[32]

Government phonology makes no distinction between input and output, nor between underspecified lexical representations and derived surface forms. There is only a single level of representation and syllable structure (or rather OR packages), and all sorts of other government and licensing relations (in part expressing metrical structure) apply to it. The *phonological representation* contains all the information that is necessary to arrive at the *phonetic interpretation*. There is no independent level of surface phonetic form, there is only phonetic interpretation. The question whether rules or processes apply to the phonological level, e.g. to insert elements or skeletal slots in certain circumstances is discussed in Kaye (1995). In any event, these processes are not extrinsically ordered, rather they apply whenever their structural description is met. Such processes however, if necessary, would not necessarily create a second phonological level. Rather they would be *intralevel* rules in the sense of Goldsmith (1993), cf. below. In chapter 6, this volume, and in van der Hulst & Ritter (1999, in prep.), we refer to government phonology as essentially monostratal. We argue there that even intralevel rules may be unnecessary. Since GP makes no input-output distinction there is no room for the OT-idea of richness of the base.[33]

Goldsmith (1993) and Lakoff (1993) propose theories that appeal to three levels; cf. Goldsmith (1993: 32):

(34) a. M-level, a morpho-phonemic level, the level at which morphemes are phonologically specified.
b. W-level, the level at which expressions are structured into well-formed syllables and well-formed words, but with a minimum of redundant phonological information; and
c. P-level, a level of broad phonetic description that is the interface with the peripheral articulatory and acoustic devices.

If we identify the P-level with what government phonology takes to be the phonetic interpretation, the question remains whether the distinction between the M-level and the W-level is motivated. Government phonology seems to adopt a W-level only. We refer for further discussion of this issue to van der Hulst & Ritter (1999, in prep.)

Finally, let us address a 'level' distinction that is made in many works on the syllable where we find a distinction between phonological and phonetic syllables. The phonetic syllables are assumed to be more 'concrete' and closer to what we actually produce or perceive (cf. Baumann 1999). Making the distinction between these two types of syllables is useful only, if one wishes to argue that the structure of both types of syllables can differ with respect to the same word or type of string. A simple example involves the notion of ambisyllabicity. While phonologically a VCV sequence would always be parsed V.CV, there may be considerations for saying that it is actually pronounced as ambisyllabic. In van der Hulst (ms.), cases of this type are referred to as 'structure paradoxes'. In addition to a difference of this type, we may encounter the fact that a specific word or string can be pronounced in a variety of ways in a single language. This follows from the fact that all languages allow various registers or styles involving differences in the realization of words. In those cases, a single phonological syllable structure could correspond to a variety of phonetic syllabifications. Finally, two levels of syllabification have been proposed in the context of the notion of resyllabification. Sometimes, a string needs to be syllabified in a particular manner to motivate processes of insertion or deletion. Then, subsequently, these processes motivate a different kind of syllabification. Resyllabification also emerges when words are combined and final consonants syllabify as onsets to following words that start with a vowel.

The question arises as to whether we assign such differences to the phonetic implementation component (as government phonology would argue) or whether we really envisage another level of representation characterized by different parameter settings or by a separate set of constraints. Van der Hulst (ms.) argues in favor of a separation of lexical prosodic (phonological) structure and post-lexical prosodic (phonetic) structure, claiming that syllable structure must be represented independently by different grammars at both levels. Post-lexical syllable structure is, in a sense, 'less abstract' and is part of the implementation systems in forming the interface to the production and perception system of language, whereas the lexical level is more directly relevant to storage in terms of cognitive structures. He tentatively suggests that the lexical level is most appropriately analyzed in terms of a parametric system in combination with a small set of dominant principles (as in government phonology), leaving open the possibility that OT may be suitable for the analysis of the phonetic implementation end of post-lexical structure, i.e. the level where the 'battle' between production and perception is most vividly present.

5. Summary and conclusions

In this chapter we have reviewed some of the important issues in syllable theory. Our focus was first on making a distinction between core syllable structure and edge effects, arguing that the complexities arising at edges should not prevent us from postulating a limited array of syllable types. Then, after briefly looking at the reasons for having syllable structure in our representations, we discussed a variety of different views on syllable structure. Here we clearly showed our own preference for a government-phonology style onset-rhyme theory. Finally, we considered the issues of levels of representation, arguing against the input/output distinction that is made in classical OT, and against the three-level model of Goldsmith and Lakoff and in favor of a monostratal model, or possibly one that separates the lexical phonological representation from the post-lexical phonetic representation where the latter forms part of the phonetic implementation system.

Notes

1. Often such statements ignore the precise structure of the V-part, i.e. whether this part allows contrast for vowel length and or diphthongs.
2. We assume here that Dutch has a tense-lax distinction in the vowel system, rather than a length distinction; cf. van Oostendorp (1995) and van der Hulst & Ritter (in prep.).
3. Lowenstamm (1996) proposes a theory, called strict CV theory, which claims that all languages are composed of CV syllables only (cf. chapter 6, note 25). Here we do not presuppose this theory and merely say that some languages may be strictly CV, despite the apparent occurrence of more complex syllable types in the language.
4. In the strict CV version of GP (cf. footnote 2) even such structures are reduced to CV units only.

5. For a government-based analysis of Dutch syllable structure cf. van der Hulst & Ritter (in prep.).
6. It has also been suggested (e.g. in Pulgram 1970) that the domain of syllabification can differ from language to language, or that rate of speech can have the effect of increasing the size of the domain. If the domain of syllabification apparently exceeds that of 'words' and involves phrasal construction, it would seem that syllabification must be post-lexical. The evidence for post-lexical syllabification most typically is that word-final consonants syllabify as onsets of following words that start with a vowel.

   If, in addition, there is evidence for lexical syllabification (based on phonotactics), a process of resyllabification seems necessary. We return to this issue in section 4.
7. A complication in evaluating the different analyses involves subtle differences in the emergence of schwa-like epenthetic sounds.
8. Cf. Blevins (1995) for introducing the syllable and generalizations with respect to syllable typology. Also see Ewen & van der Hulst (1999), chapter 3.
9. The reasoning here is not flawless according to adherents of government phonology, who recognize units like onset and rhyme, but not the syllable; cf. chapters 6 and 7, this volume.
10. In general, government phonology seems to claim that organization above the onset and rhyme level involves head-dependent relations that do not correspond to constituency. For discussion, cf. Harris (1994), Ritter (1998), Brockhaus, this volume.
11. Goedemans (1998) convincingly reanalyzes some of the languages where 'onset weight' has been claimed to play a role.
12. The notion of stress-bearing units, roughly, corresponds to the notion of mora.
13. Cf. Harris (1990) for the role of segmental complexity in government phonology; complexity is in an inverse relationship to sonority, as Harris formulates it.
14. This is derived from the principles that government is strictly directional and local; cf. Brockhaus, this volume.
15. There is always a skeletal point in the representation of an empty nucleus; cf. chapter 6, section 2.2.1.1, this volume.
16. Such ternary structures would be excluded if government is strictly (mono)directional; cf. note 14 and section 2.2.1.5 in chapter 6, this volume.
17. Van der Torre (1998) proposes such structures for coda-onset sequences.
18. The phrase 'head-body' has become confusing, now that we have called the rhyme (i.e. the body) the head of the syllable.
19. There are also versions of the moraic approach which maintain the skeletal level, essentially claiming that length and weight are two different issues (cf. Lahiri & Koreman 1988 and van der Hulst 1984). cf. section (d) below, for other reasons for separating length and weight, involving geminates.
20. Van der Hulst & Rosenthal (to appear) claim that the weight-contribution of (non-onset) consonants can even depend on the position in the word, whereas Hayes (1995) suggests that it can depend on the level in the derivation; cf. below.
21. Avoiding the possibility that the computation of weight involves two different parameters (one looking at branching of the nucleus and one counting units in the rhyme) we could eliminate the distinction between nucleus and rhyme. Both van der Hulst (1999a) and Ritter (1999) separately have appealed to this approach. The difference in the two approaches lies in the manner in which non-moraic segments are captured, either in a representational alternative, i.e. not as rhymal dependents of the branching rhyme, as in Ritter (1999), or by parameterization in terms of the threshold parameter (van der Hulst 1999a). In the latter case, qualifying as a weight-unit, then, follows directly from the threshold parameter without being represented in the syllabic structure. Essentially, this is the approach in van der Hulst (1999a), who treats moraicity as a 'label' that is assigned to segments that meet the threshold value. A version of this approach is incorporated in chapter 6, section 2.2.1.5, this volume.
22. Selkirk's (1990) double-root theory of length addresses the same problem by representing geminates with two root nodes, thus attributing the length-expressing capacity, which others attribute to the skeletal tier, to the root tier.
23. We assume here that the facts as reported in Davis (1999) are correct. We have not looked into that ourselves.
24. In chapter 6, section 2.4.2, such geminates are called 'real'. They are distinguished from 'fake geminates' which involve two onsets with an intervening empty nucleus. Kaye (1986) points out that fake geminates can be preceded by long vowels, while real geminates (coda-onset geminates) cannot. In the languages that Sherer and Davis discuss, fake geminates, we must assume, are adhocly excluded.
25. Cf. DeChene & Anderson (1979), Wetzels & Sezer (1986).
26. A potential example of initial geminates is found in Leti. Van der Hulst & van Engelenhoven (1995) analyze these word-initial CC-sequences as two onsets that are separated by an empty, silent nucleus.
27. Onset geminates have been claimed to exist. Cf. van der Hulst & Engelenhoven (1995) for an analysis of alleged onset geminates in Leti.
28. Optimality theory is not, however, committed to any specific representational theory of the syllable. In practice, however, almost all researchers follow some version of moraic theory. Polgárdi (1998) applies OT to a government-style theory. OT, in other words, is not a *representational* theory, but a *derivational* theory in the sense of representing a view on the relation between input and output.
29. Goldsmith (1993) offers a very useful discussion of the notion 'level'.
30. The underlying level is in fact preceded by a lexical level which allows underspecification and m/u-marks in addition to + and – values; cf. Kaye (1995) for discussion.
31. Apart from those that would result from allowing more than one lexical-morphological level, and/or a distinction between lexical and post-lexical phonology. We will not discuss lexical levels here and return to the lexical/post-lexical distinction below.
32. A syllabified representation is not necessarily redundant because one might adopt the view that given the syllabic (and higher prosodic) organization, the linear structure of segments is predictable; cf. Anderson (1987), Cairns (1988), Golston & van der Hulst (1999).
33. The claim that lexical entries are syllabified is not contradicted by languages that allow non-concatenative morphology, since there is no demand that the OR-constituents are actually filled with segmental content.

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Part V: Other approaches

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