VERTICAL LOCALITY: SEGMENTAL INTEGRITY AND THE HEAD CONSTRAINT

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FIRST GENERALS PAPER

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Contents

Abstract

This paper investigates the classical problem of chosing between a monosegmental and a bisegmental analysis of complex consonantal events. I propose both a static approach and a dynamic approach to this problem.

First, based on a broad overview of the existing models of syllable theories, I formulate a set of static criteria for selecting between different structural analyses: the Sonority Criterion, the Unique Combination Condition, the Phonotactic Condition, the Independent Existence Condition and the Homorganicity Condition.

Second, my study of the behavior of complex events under reduplication in Gothic, Sanskrit and Klamath, indicates that the complex events fall into two classes: the events that

undergo full copy and those that undergo partial copy. In partial copy, the head alone is copied while the dependent is not. Accordingly, it is proposed in this paper that the independent variation of the event's head under the effect of a phonological rule reveals the structural status (a complex onset or a complex segment) of the unit.

An important link is demonstrated between the structure of onset events and phonological rules in terms of accessibility. Thus, the Complex Onset Criterion requires that the head of a complex onset be accessible to phonological rules independently of the onset dependent. This leads to the Head Constraint for complex segments that limits access to their internal structure. Thus, complex onsets differ from complex segments in Vertical Locality, which describes the structural depth of representation at which rules may operate.

This approach leads to a cross-linguistic analysis of phonetic events in Gothic, Sanskrit, Klamath, Florentine Italian and Leon Spanish and provides evidence for complex onsets. It also leads me to suggest the Segmental Integrity Hypothesis claiming that all rules accessing the internal structure of complex segments are phonetic rules.

1. Introduction

This paper discusses the nature and the structure of the onset constituent, focusing on the question of the proper structural analysis of complex phonetic events.[1] I will use the word 'event' here in the pre-theoretical sense of an element or a sequence of elements in the phonetic representation which I here take to be a narrow phonetic transcription. Some phonetic events are simple while others are complex. For example, [t] and [k] are simple consonantal events, while [tr], [ts] and [mb] are complex consonantal events. Other complex consonantal events are sounds with a secondary articulation or with more than one articulation with the same constriction degree. In general complexity results from the fact that we encounter a sequencing of phonetic features, rather than a co-temporal realization.

I assume that phonological architecture includes the levels of the underlying representation and phonetic representation, distinct from the level of phonetic implementation which lies outside phonology.

An event's complexity at the phonetic level does not necessarily tell us whether the event is a single segment or a segment sequence in the underlying representation. The question is thus: within a given theory of phonology, which structural analyses of a complex phonetic event are permissible, and which criteria allow us to select the proper analysis from the set of available analyses for the event in question?

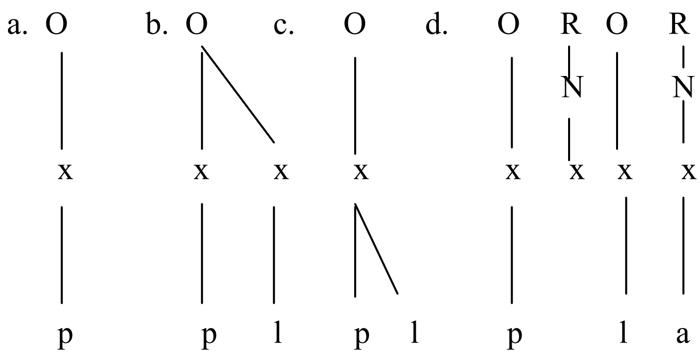
In the course of this investigation, I will propose and motivate two locality constraints (the Head Constraint and the Segment Integrity Constraint) which limit the way in which phonological processes can access phonological information. Issues of locality are of central importance to phonology (and linguistics in general). However, while most work on locality focuses on the 'horizontal distance' between targets and environments, little attention has been paid in phonology to what I will call 'vertical locality': the manner in which rules have access

[1] I am very grateful to Harry van der Hulst for advising and guiding me through this work. I also would like to thank Andrea Calabrese, William Snyder, Jon Gajewsky, Diane Lillo-Martin, Jonathan Bobaljik and Daniel Hirst for their challenging questions and stimulating comments. Thank you also to José Riqueros-Morante, Corina Goodwin and Lyn Tieu for suggestions, and to Maria Osina for help with the Sanskrit glosses.

to hierarchical structure. I will show how reasonable assumptions about the degree of *vertical access* can provide a basis for choosing between competing analyses of complex phonetic events.

In this paper, I adopt the major tenets of Government Phonology, or GP (Kaye, Lowenstamm and Vergnaud (1990)). This theory allows three phonological structures as underlying representations of complex phonetic events in the onset. For clarity, let us use [pl] as an example of a complex phonetic event. Under one analysis (the 'complex onset analysis'), a complex consonant event like [pl] is the phonetic realization of a complex onset (1b); under a second analysis (the 'complex segment analysis'), it is the realization of a single underlying onset segment (1c). The two portions of [pl] may also be analyzed as independent segments occupying the position in two simple onsets separated by an empty Rhyme (1d); I will refer to (1d) as the "double-onset" analysis.

(1)



In section 2, I will discuss Government Phonology in more detail and compare it to Dependency Phonology and other theories, focusing on the structure of phonological representations.

Leaving (1d) aside for the moment, the choice between (1b) and (1c) concerns a classical problem in phonology. The choice between a monosegmental and bisegmental analyses of specific phonetic events has been repeatedly addressed in structuralist, functionalist and generative works, such as Trubetzkoy (1939), Martinet (1939, 1970), Morciniec (1958, 1960), Feinstein (1979), Bolozky (1980), Herbert (1986), Downing (2005), Scheer and Segeral (2003), Calabrese (2005) and Morrison (2009), among others. From the perspective of linguistic phonetics, the segmental status of complex phonetic events has been examined in Ladefoged and Maddieson (1996).

Based on the results discussed in the overview (section 2), I will formulate, in section 3, a set of criteria which allow us to select between different structural analyses with reference to complex phonetic events in the onset. These are the Sonority Criterion, the Unique Combination Condition, the Phonotactic Condition, the Independent Existence Condition and the Homorganicity Condition. In section 4, I examine the patterns of reduplication of complex consonantal events in Gothic, Sanskrit and Klamath, and establish a cross-linguistic reduplicative typology (by event type).

This leads me to propose, in section 5, a new criterion for complex event analysis (the Complex Onset Criterion) and a locality constraint (the Head Constraint) which limits the way in which phonological processes can descend into hierarchically structured phonological objects (Vertical Locality). Section 6 provides independent support for the Head Constraint.

Finally, the consideration of Vertical Locality in terms of structural depth shows that, unlike complex onsets, complex segments display some sort of integrity, which I characterize in the Segmental Integrity Hypothesis. I expect to investigate this hypothesis, its validity and its implications with respect to the properties of rules as part of a future project.

2. The theories of syllable structure

In this section, I review different approaches to the syllable. My main goal is to provide a brief overview of Government Phonology and to compare this approach to various other approaches. I briefly recall the re-introduction of the syllable after Chomsky and Halle (1968) SPE hereafter. It is well-known that the syllable was regarded as part of phonological representation before SPE and in other approaches co-temporal with SPE. However, I do not aim at offering a full history of the syllable; for a broader coverage of syllable theories, see Fisher-Jørgensen (1975), Awedyk (1975), Anderson (1985) and Fox (2000).

In generative theory, the concept of "syllable" has known considerable evolution. Indeed, in the tradition of Classical Generative Phonology, as represented by Chomsky and Halle (1968) - SPE hereafter - the phonological representation was considered to be linear, that is, phonological strings were composed of distinctive feature matrices and boundary symbols. Rules could refer to both. The feature matrices were neither structured internally nor organized into larger phonological structures. In particular, the syllable was not given any place in the SPE formalism.[2] Ever since the publication of SPE, it has been repeatedly argued that phonological generalizations are effectively captured only if phonotactic statements and phonological rules explicitly manipulate syllables and their constituents. It was thus suggested that the syllable has an important role to play in phonological theory. A number of researchers supported the view that the syllable has an internal structure. It was it is not given in the lexical representation but derived by syllabification procedures.

Thus, a host of proposals concerning the syllable were made after the publication of SPE. Below, I briefly pass in review major approaches to the syllable comparing each to Government Phonology, the approach adopted in this paper.

2.1. Natural Generative Phonology

Soon after the appearance of Chomsky and Halle (1968), it has been argued that a proper theory of representations, as part of a generative phonological framework, must formally acknowledge the syllable. The research of the 1970's was marked by the return of the syllable into generative theories, originally re-introduced within the framework of Natural Generative Phonology developed in Vennemann (1972, 1974) and Hooper (1972, 1976). In an early article

[2] It is true that some phonological rules (for example, Trisyllabic Shortening) do refer to the syllable. However, in SPE, this reference is always indirect since the syllable is not notated using a symbol at any level of representation, thus preventing the rule from referring formally and explicitly to the syllable as theoretically acknowledged unit. It would seem (as recalled by M. Halle) that the syllable had been left out of the SPE grammar formalism to make economy of symbols rather than for adequacy considerations.

on the syllable in phonology, Vennemann (1972) argues that many phonological generalizations like those related to consonant clusters in English stress assignment and in Modern Icelandic vowel lengthening pose a serious challenge to the Classical Generative Phonology because it does not recognize the syllable and syllabification. He claims that rules of the Classical Generative Phonology lack motivation and significant theoretical generalizations about rule application fail to be captured. Vennemann suggests enriching the theory of representations with the syllable as a unit to which rules may refer.

An important piece of evidence adduced by Vennemann to argue for the rules of this sort comes from Final Devoicing in German, which Vennemann analyzes in terms of resyllabification. Vennemann views resyllabification in terms of the shift of a syllable boundary rather than as syllable margin reassociation. Thus, Natural Generative Phonology focuses on syllable boundaries rather than on its internal structure. It is a major argument for syllables put forth by the NGP that phonological description must make crucial reference to syllable *boundaries*.

To that end, Hooper (1972) states specific syllabification conventions that insert the syllable boundary (notated with a "$") in the strings of phonological segments and then re-adjust the location of the $ inside those strings. She proposes that the syllabification conventions are sensitive to the respective "strength ranks" of the segments which they manipulate. Strength ranks are abstract measures, of relative nature, organized along a scale (a "strength hierarchy"). In Hooper's approach, strength hierarchies are language-specific while the syllabification conventions are probably universal (both for Hooper and for Vennemann).

NGP also reconnected with the tradition of general principles for syllable division. Thus, under the name of the "Law of initials", Vennemann (1972:11) re-introduces the common distributional principle used to determine if a consonant sequence is a legitimate word-internal onset. The law requires that "medial syllable-initial clusters should be possible word-initial clusters". NGP treats resyllabification as a repair to the violation of the law of initials which is implemented by a set of ordered rules (interacting with other rules) shifting the syllable boundary with respect to the consonants in the cluster. Further, Murray and Vennemann (1983) and Vennemann (1988) observe that the world's languages exhibit a very strong tendency for the coda-onset sequences ('interludes') to consist of a sonorant followed by an obstruent. They capture this observation in the form of the Syllable Contact Law (Murray and Vennemann 1983: 520). It is stated as a preference on segment sequencing involving "Consonantal Strength", a notion close to that of sonority (Murray and Vennemann 1983: 519).

I note here that Government Phonology (GP) and Head-driven Phonology (HDP; van der Hulst and Ritter 1999) also regulate which segment sequences are possible between two vowels. But, unlike the NGP's approach to *interludes* in terms of "preferences", GP and HDP set in-violable constraints of a general form (a "principle"). Thus, with respect to coda-onset sequences, GP and HDP impose an absolute ban on obstruents in the coda position: two adjacent obstruents may not be dominated by the coda and onset positions, a result derived from the coda licensing relation. The tendency to account for linguistic generalizations with soft constraints ("preferences") is a typical feature of Natural Generative Phonology, which perhaps explains why some of its "laws" were later retranslated into violable constraints within OT (sometimes with a loss of generality in the statement). By contrast, Government Phonology and Head-driven Phonology differ sharply from NGP (and OT) in that their grammars are principle-based, that is based on "hard" positive constraints, expressed as general statements some of which allow a small number of parametric choices.

2.2. The autosegmental model of Kahn (1976)

The first explicit non-linear generative model of the syllable is Kahn (1976). In this dissertation, the autosegmental formalism originally devised for tonal systems (Goldsmith 1976) is applied to syllable theory. Kahn argues that the resulting model provides the proper account of a number of syllable-related effects in English and is therefore motivated empirically.

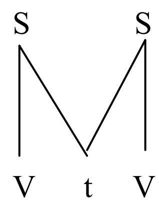
The model proposed by Kahn is tiered, with different kinds of entities placed on different tiers. The syllable is represented as a sequence of segments located on the segmental tier associated with the [syllabic] feature on another tier. A syllabification algorithm in Kahn (1976) builds syllables by associating every segment with [syllabic].

Kahn's model differs from many other models and from GP in particular, in that it does not recognize syllable constituents. Furthermore, dependency and licensing relations are not part of Kahn's theory. According to it, the prevocalic consonants associated to a syllable node merely form a consonant sequence without having the status of a phonological constituent.

Kahn's theory shares with NGP a focus on marking syllable boundaries. Both theories also do not propose any kind of internal structure for the syllable.

A notable difference with NGP is that ambisyllabicity (syllable overlap) is allowed in Kahn's model. It is captured in the syllabic representation as the affiliation of a single segment to two syllable nodes, as shown in (2):

(2)



Kahn adduces evidence for ambisyllabicity from his analysis of flapping of intervocalic /t/ in English as contrasted with its aspiration syllable-initially. He claims that /t/ is realized phonetically as a flap due to its double association to two distinct [+syllabic] autosegments in the underlying representation.

Like Kahn's autosegmental model, Dependency Phonology acknowledges ambisyllabicity. Note that no language has both ambisyllabic consonants and geminates, thus it is possible that the so-called ambisyllabic consonants are in fact geminates, which implies that ambisyllabicity may not be a necessary concept; see van der Hulst (1985).

2.3. Moraic Phonology

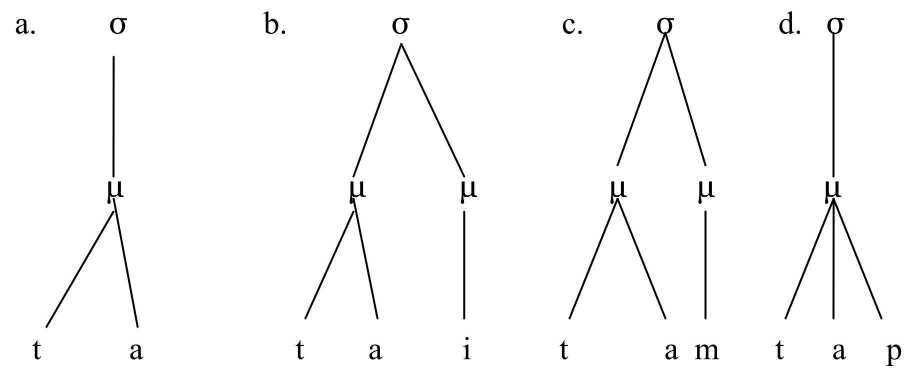
Another way of approaching syllable-internal structure is to give the central organizing role to the *mora*. Following this approach, called moraic phonology, the segments are grouped into moras and moras into a syllable.

Although the mora as a unit of weight had been suggested at least since works by Trubetzkoy, the models of syllable organization explicitly involving moras as a structural unit were proposed considerably later. The first moraic model of the syllable was proposed in a series of publications by Larry Hyman in the early 1980s; see, in particular, Hyman (1983, 1984, 1985). Different from this is the now widely accepted model of Hayes (1989). Below, I briefly present both.

2.3.1. The syllable model of Hyman (1984, 1985)

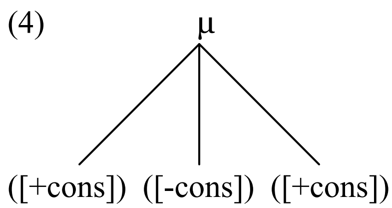
It is proposed in Hyman (1985) that the configurations in (3) constitute the set of permissible syllable structures built in terms of moras:

(3)



Naturally, the question arises with respect to (3) regarding the size and structure of a mora in its maximal expansion. Hyman (1985) claims that a maximally expanded mora follows the template shown in (4).

(4)

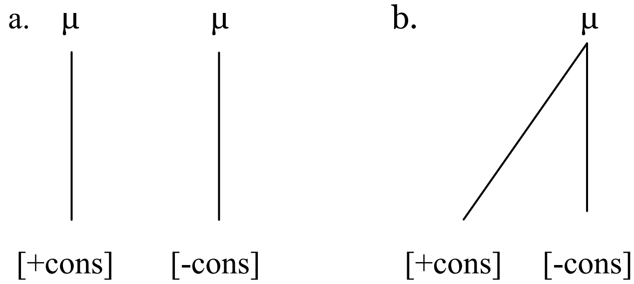


The template above groups three feature matrices (each specified for [consonantal]), with the central segment as a possible peak, that is, a segment that could surface as a peak in the output). Also, the occurrence of each of the [consonantal] features in the sequence is optional, independently of the other two, as the parantheses indicate. Hence, CV, VC, CC or CVC, are the only possible CV shapes for moras in Hyman's model.

Regarding syllabification, moraic structures in Hyman (1984, 1985) are derived by mora assignment rules - the onset-creation rule (OCR) and the margin-creation rule (MCR). These rules modify the underlying associations with the mora. Some of syllabification rules are universal, accounting for the properties of moraic and syllabic organization shared by all languages.

Now, I shall briefly touch upon the rules syllabifying the prevocalic material. Following Hyman (1985: 15). in a [+cons] [-cons] sequence, in (5), the OCR deletes the mora of the [+cons] segment, *i.e.* the left mora in (5a), while keeping the feature matrix of the consonant and associating it to the right mora (dominating the [-cons] segment). The output of the OCR is a [+cons] [-cons] sequence associated to one mora, as described in (5b).

(5)



If additional prevocalic consonants are available, they are adjoined to the onset by onset adjunction rules (OAR's). Similarly to the OCR, the OARs delete their own moras and associate them to the mora of the following vowel.

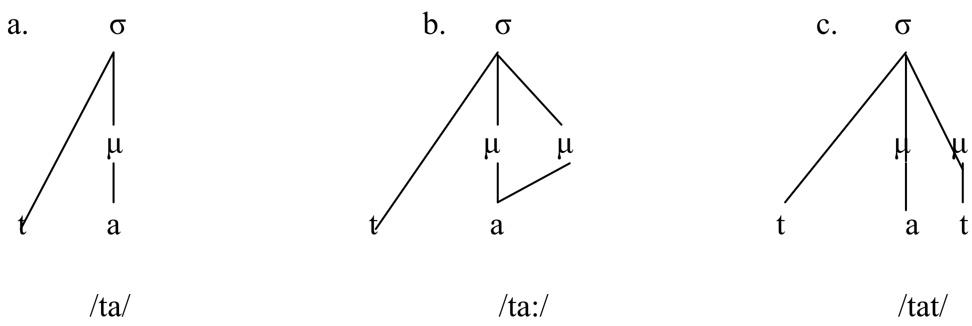
An original proposal in Hyman (1985) is that syllabicity is not an obligatory part of the phonological representation as he claims that a language can have syllabicity (as a peak potentially carrying a metrical beat) without the syllable. Hyman (1985: 19-32) claims that this is the case of Gokana. Hyman analyzes this language in his framework as having no syllables while having moras and concludes that, since syllabicity is dependent on the mora, the universal carrier of syllabicity is the mora, not the syllable. Therefore, prosodic representations universally have a mora tier, whereas the availability of a syllable tier is language-specific.

Assuming that syllabicity is dependent on the mora and using the property of OCR to prevent a [+cons] segment from having a mora if it is immediately followed by a [-cons] segment, Hyman (1984, 1985) deduces the non-syllabic nature of the prevocalic segments. That is, prevocalic consonantal material is non-syllabic because, as a result of the application of the OCR, it loses the mora of its own, surfaces without any mora, and cannot therefore contribute to syllable weight. This is a way of accounting for a nearly universal weightlessness of onsets[3].

2.3.2. The syllable model of Hayes (1989)

The moraic model that was originally developed in Hayes (1989) allows for the syllable structures in (6):

(6)



[3] Evidence for onset weight was found in several languages should also be acknowledged. The most known case is Pirahã (see Everett an Everett 1984, Blevins 1995: 237 fn.25). A prosodic system characterized by currently emerging onset-sensitive accent is found in Pattani Malay (Abramson 2004, Hajek and Goedemans 2003).

An important difference between moraic phonology and GP consists in the status of the prevocalic consonant(s) as an immediate constituent of the syllable. In GP, the onset is considered to be a phonological constituent. Therefore, GP theory predicts that the onset material may be referred to by phonological statements. The onset contracts lateral dependency and licensing relations in GP and its structure may be subject to parametric statements in the phonological grammar. Unlike GP, moraic phonology does not grant the onset the status of a syllable constituent. Moreover, in moraic phonology, prevocalic material has no status whatsoever within the syllable. The prevocalic material is simply an adjunct of the syllable node associated with it by a syllabification rule.

McCarthy and Prince (1986:3) and Hayes (1989: 254) emphasize that (6) formally captures the syllable weight distinction by making light syllables monomoraic (6a), as opposed to heavy syllables which are bimoraic in this approach (6 b,c). They claim that this makes moraic phonology superior to that of other syllable theories with respect to formal expression syllable weight.

However, as noted by Harry van der Hulst (p.c, 2010), if we set apart the prevocalic material internal to the syllable, we see that the structure of the syllable unit in moraic phonology is the same as the structure of the Rhyme (R) constituent in GP in that both nodes (R, σ) are at most binary branching. Further, weight is determined in both theories by the count of timing units contained in R or σ so that the R node or the σ node dominating two units of timing is heavy; otherwise, it is light. We thus see that the labeling of timing units as skeletal positions (“X”) or as moras (“μ”) is merely a matter of notation. To conclude, the claim that syllable representations involving moras capture weight distinctions better than constituent representations in GP is not true.

Comparing Kahn’s flat model and the moraic model, we can say that the models are similar except that the lines associated to ‘non-onset’ material *are* (in case of [+syllabic] segments) or *may* be (in case of post-vocalic consonants) augmented with a mora label; the latter option is called ‘weight by position’.[4]

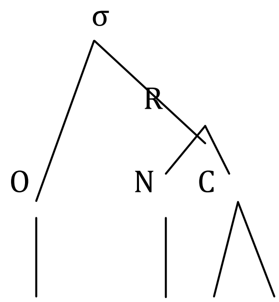
2.4. The Onset-Rhyme theory

The Onset-Rhyme approach to syllable structure has a long tradition (see Awedyk 1975). Pike and Pike (1947) and Hockett (1955) are the early works which probably had most direct impact on the generative thinking of the 1980s and early 1990s. I shall focus here on the post-SPE developments.

In the Onset-Rhyme approach, the syllable is composed of two constituents, the onset (O) and the rime (R). The rime branches further into two constituents, the nucleus (N) and the coda (C), as represented by the following tree:

[4] Unless it is the left side of a geminate in which case it has a mora universally (cf. Hayes 1989, Zec 2007 for details).

(7)



The Onset-Rhyme approach results from a collective effort over a time period, so certain points of the approach vary across specific proposals. For example, not all versions of the Onset-Rhyme approach allow the Coda to branch. Also, some lack the Appendix originating in Fudge (1969).

Finally, it is worth noting that, among various approaches to syllable-internal structure, the Onset-Rhyme approach bears most resemblance to GP.

2.4.1. The contribution of Fudge (1969)

Through a detailed examination of English phonotactics, Fudge (1969) makes a number of generalizations over phonotactic patterns in this language. He captures these in what he terms "collocational restrictions", *i.e.* syntagmatic constraints taking the form of implicational statements involving segments and positions hosting them within the constituents.

Following Fudge's analysis, the English syllable has a hierarchical branching structure. The syllable node immediately dominates three others, representing immediate constituents of the syllable. These are Onset, Rhyme and Termination. The Rhyme further branches into a Peak constituent and a Coda constituent.

Fudge posits a Termination node which is the rightmost daughter of the syllable node, sister to Onset and Rhyme. The Termination node typically hosts segments of a derivational suffix. Upon suffixation, these are syllabified. Thus, the single segment making up the suffix /θ/ added to the stem to form [sɪksθ] ("sixth") is dominated by the Termination. Note that Fudge's Termination is the origin of the "Appendix" found in later works (van der Hulst 1984, Ewen and van der Hulst 2001).

The most lasting contributions of Fudge (1969) are probably this argument for syllable constituency from phonotactic constraints supported by a minute analysis of those in English.

2.4.2. Later proposals in the Onset-Rhyme theory

In the Onset-Rhyme approach, the basic argument for the syllable and syllable constituency has the phonotactics as a source. An additional argument comes from the idea that linguistic devices such as rules operating on segments and prosody (accent or tone) must make reference to the syllable (or a part of it) as a unit of structure. According to Selkirk (1982), "the most general and explanatory statement of phonotactic constraints can be made only by reference to the syllable structure of an utterance".

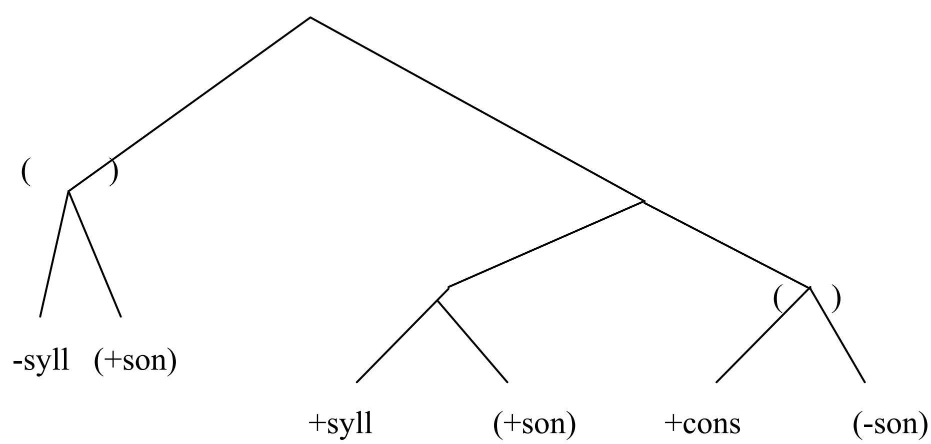
Selkirk formulates what she terms the "Immediate Constituent principle": the closer two positions within a syllable's constituent structure, the tighter the constraints on the co-occurrence of their segments. The Onset-Rhyme theory and Selkirk's work, in particular, claim that a theory of syllable structure incorporating this principle and producing constituent-based analyses is superior to linear theories, including those theories that represent syllable edges without representing syllable structure (such as NGP and Kahn's model).

The generative Onset-Rhyme approach, especially in the early years (since circa. 1978), is characterized by the "templatic" approach to the syllable. Its core is a "syllable template" - a set of constraints on the internal structure of possible syllables in a language (the structure being expressed as a tree). Additionally, phonological grammar is claimed to contain the phonotactic constraints relating the segments occuring in the positions within a given constituent, These constraints (or "collocational restrictions") are implicational statements. Taken together, the template and the phonotactic constraints serve as the conditions on the well-formedness of the syllabic representations for a given language, defining its possible syllables.

Technically, in the templatic approach of Selkirk (1982), the well-formedness of any syllable in a given language is checked by matching the tree structure of that syllable with the structure of the template. If it is non-distinct from the template, the syllable representation is considered well-formed. (A syllable is non-distinct from the template if the branching pattern and the featural content of syllable positions are the same as those of the template.)

For example, Selkirk (1982) proposes that the syllable template for English looks as in (8).

(8)



The other central components of the OR theory are the Sonority Sequencing Generalization (SSG), the sonority scale and the Minimal Sonority Distance principle (MSD). Although the notion of sonority and its organizing role were acknowledged long before the emergence of the OR approach (cf. Sievers 1881; Jespersen 1904 a, b; Vennemann 1972; Hooper 1974), the particular implementations of those mechanisms have been proposed within the OR approach. Together, they define the class of possible units of prosodic organization lying between the syllable level and the segmental level.

According to the Onset-Rhyme theory, the SSG is necessary, but not sufficient, for defining possible syllable structure. Thus, the SSG will allow any obstruent-sonorant clusters as onset. However, in certain languages, some of those clusters need to be filtered out for independent reasons, and this is achieved by the MSD parameter. The MSDs, in turn, set language-specific sonority thresholds. To allow for the measurement of sonority distances, (groups of) segments are traditionally ranked on a sonority scale and assigned sonority indices. A version of the Sonority Sequence Generalization and a sonority scale, proposed in the literature, are given below.

(9) a. *The SSG* (Selkirk 1984: 16; Steriade 1982: 92)

In any syllable, there is a segment constituting a sonority peak which is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.

b. *A version of the sonority scale* (cf. Steriade 1982: 94-95)

$\longrightarrow$

0,5	1	2	3	4	5	6	7	8	9	10
p	b	f	v		m					
t	d	θ	z, ð	s	n	l	r	i,u	e,o	a
k	g									

It was also shown in the literature that the SSG and the MSD alone do not constrain segment sequencing sufficiently, as certain outputs generated by combining segments under SSG and MSD impossible in certain languages, like *[dl] and *[tl], which are impossible in English. The standard solution was to account for the excluded clusters via *independent* formal mechanisms (e.g. the OCP-Place, co-occurrence filters, or the implicational "collocational restrictions") constraining the co-occurrence of place features on adjacent segments. Thus, for example, [dl] and [tl] were ruled by a filter *[-cont, +cor,][+cor, +lateral] or another filter constraining the combinations of coronal consonants. Importantly, the MSD constraints were found to be insufficiently restrictive.

2.5. The X'-model of Levin (1985)

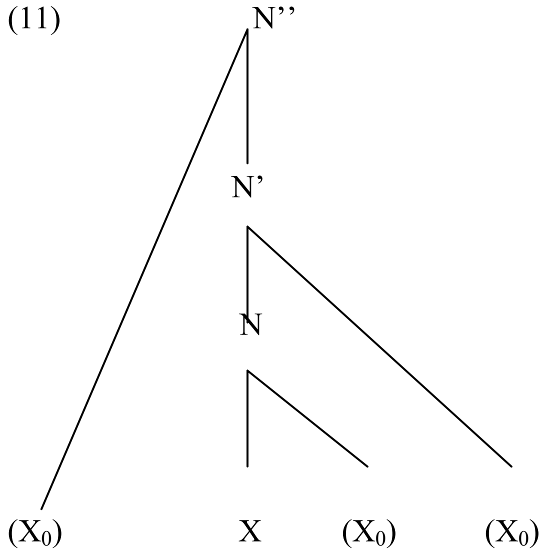
Levin (1985) develops an X' model of syllable structure which expresses the constituency in terms of categories and projections within the syllable.

In this model, the syllable is constructed by a system of rules which follow the X-bar schema available in the versions of Government and Binding theory as of mid-1980's . One effect of this rule system is the construction of nodes domination the Nucleus (N), by projecting N into N' and then N' into the maximal projection N''.

(10) N''→ (Spec) N
N' → … N …

These rules in (10) generate the following basic syllable structure:

(11)



This basic structure may be further expanded by adding the neighboring peripheral segments to it through two kinds of rules: incorporation and adjunction. Incorporation rules attach additional skeletal slots either to N’ or into N’’. Adjunction rules adjoin elements to the N’’ level. Both initial adjunction and final adjunction are possible. The output of Incorporation must respect the Sonority Sequencing Generalization, the output of Adjunction may violate it. In order to account for extra-syllabicity, the X-bar model allows iterative adjunction rules. In a phrase structure model like that of Levin, the onset material is located in the specifier.

Another special feature of the X-bar model is the existence of rules which modify the skeletal tier by manipulating skeletal positions (the ‘x’s), both ‘x’-insertion and ‘x’-deletion being allowed.

2.6. The model of Calabrese (2005)

An original model has been put forth in the work by Calabrese (see, e.g., Calabrese 1994: 159, 2005, *ms*: 6-7).

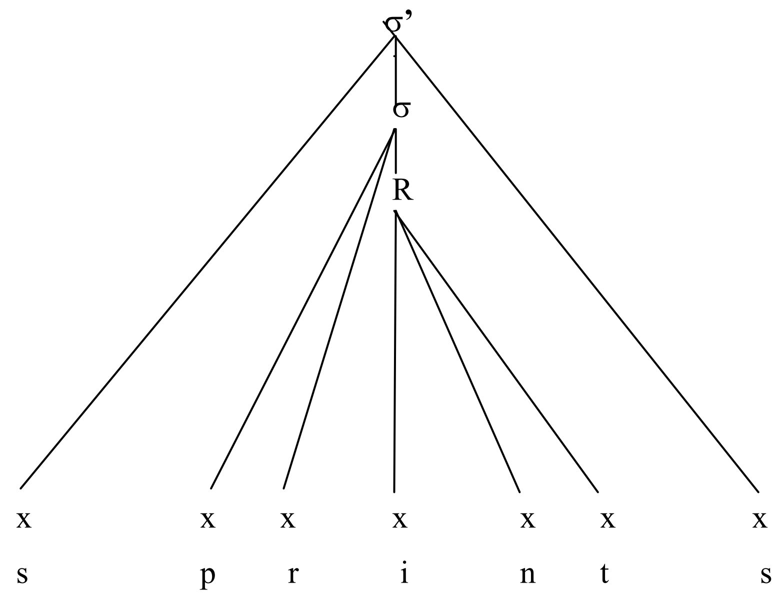
The central element is the so-called “core syllable” which serves as the domain of the main body of sequential restrictions on sounds. The structure of the core syllable obeys the Sonority Sequencing Generalization (SSG). This model assumes the version of SSG that states that, within a core syllable, sonority uniformly decreases from the Nucleus to the margins. This implies that a segment that is known to be a member of a syllable and that violates the SSG is not in the core syllable but that it is in the *appendix*. The properties of the appendices differ depending on their position with respect to the core syllable: the restrictions on the syllable-initial appendix differ from those on the syllable-final appendix.

The “extended syllable” consists of the core syllable plus the appendices. No syllable constituent intervenes between the segments external to the core syllable and the higher structure. Rather, those segments are directly attached to the extended syllable node.

So, this model does not formally acknowledge the onset as a constituent. The syllable tree thus lacks a separate onset node, the prevocalic material being directly dominated by the core syllable. In this particular respect, the model bears a resemblence with the moraic model, which also does not represent the onset in the syllable structure.

The tree in (12) representing the word “sprints” (with the extended syllable labeled σ’) illustrates this approach to syllable structure.

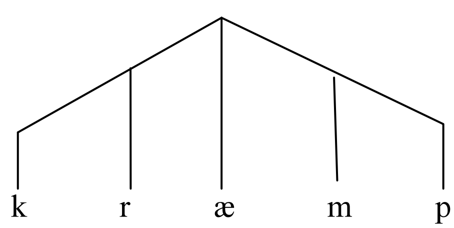
(12)



2.7. Dependency Phonology

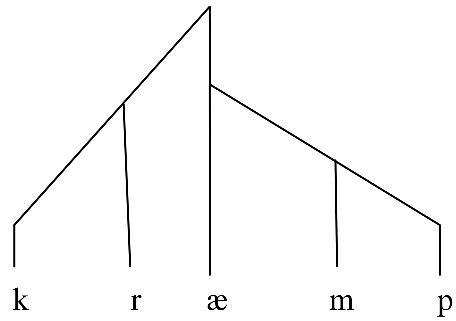
The only relations at the syllable level in the Dependency Phonology (DP) formalism are of two kinds: dependency (headedness) and precedence (linear order). DP originally lacked the notion of constituency, like dependency grammar in general. In this way, at the syllable level, every segment was a dependent of some other segment, except the syllabic, which was only the head, possibly with more than one dependent (13).

(13)



Following Anderson, Ewen and Staun (1985) and Anderson and Ewen (1987), relations within the syllable were revised giving rise to syllable structures like (14), in which the syllable peak is projected up (self-dominance).

(14)

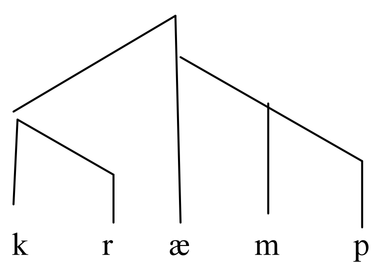


The difference between (13) and (14) is that in the latter, unlike in the former, there is a terminal node which dominates the syllabic and everything that follows but which does not dominate the prevocalic material /bl/. Thus, DP proposes to make a syllable-internal division between the two portions. This corresponds to the Onset-Rhyme distinction, later made in other approaches.

DP motivates the division based on the presence of phonotactic constraints over the prevocalic sequences and over the segment sequences from the syllabic to the syllable-final segment and there are no phonotactic constraints on sequences consisting of the onset segments and the following vowel. The same argument was also made within the Onset-Rhyme framework and later in GP.

Starting from Anderson (1986), DP makes the sonorant dependent on the obstruent head, instead of the sonorant being assigned head status and the obstruent the status of dependent, as previously proposed in DP. Correspondingly, instead of (14), the structure became now as in (15).

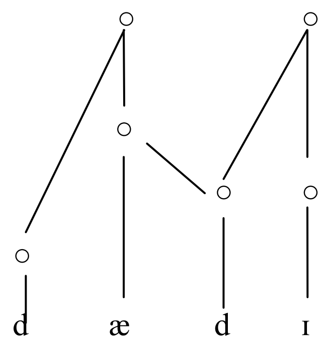
(15)



Note that the type of graphic representation initially used in DP to show the structure and the relations between the units, is a dependency graph which is not a constituent tree (unlike those of constituency-based grammars). However, the introduction of self-dominance whereby the syllabic was subordinated to itself made the dependency graph appear similar to a constituent tree structure (with an Onset and a Rime). A further important step in this direction was the reversal of the direction of dependency. Indeed, the (sub-)syllabic representation proposed by DP thus became close to that of Government Phonology, which recognizes both dependency and constituency. They differ in that Government Phonology does not give the syllable constituent status and does not allow ambisyllabicity.

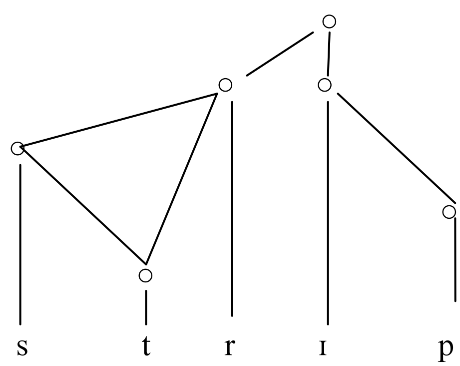
Further, DP allows a dependent to have two heads. Anderson and Ewen (1987) propose representations involving this double dependency for the case of intervocalic consonants as well as for word-initial /s/-TR clusters. Intervocalic consonants may be *ambisyllabic*, as in (16). This means that one consonant belongs to two adjacent syllables; it is both the coda of the first syllable and the onset of the following syllable.

(16)



Also, according to Anderson and Ewen (1987: 99), building on Durand (1981), word-initial /s/-TR clusters involve the obstruent's dependency both on the preceding strident and the following sonorant (17).

(17)



DP offers a unified model of suprasegmental structure, comprising the structure of the syllable and the units of higher levels (foot, word). The suprasegmental representations in DP are based on dependency at every level of structure. Given a word, a syllable peak is selected as a foot head. Then, the head of one of the feet is selected as the head of the higher unit, that is as the word head. This approach to prosodic structure is closely related to metrical theory: it shares with metrical theory the notion of headedness which it expresses as the relation between *s*-nodes and *w*-nodes. (Liberman and Prince 1977).

2.8. Government Phonology

Unlike most theories, GP considers that phonology shares with syntax the general architecture of the theoretical framework, i.e. the so-called *Principles-and-Parameters* framework. Phonological phenomena are accounted for in terms of structures and relations defined by a number of universal inviolable constraints, or *principles*, some of which are parameterized. Phonological and syntactic mechanisms are the same in kind. The grammar is a system of universal principles and parameters which is called upon to account for language universals and cross-linguistic variation. The idea that, at some level of abstraction, we find general organizational properties of grammar that syntax and phonology share, has earlier been formulated as ‘Structural Analogy’ in Anderson and Ewen (1987). The Principles-and-Parameters model of grammar is also adopted by the Head-driven Phonology (van der Hulst and Ritter 1999).

In the present paper, I adopt the Government Phonology approach to phonological constituent structure. I shall therefore discuss Government Phonology (GP) in more detail than the other syllable theories.

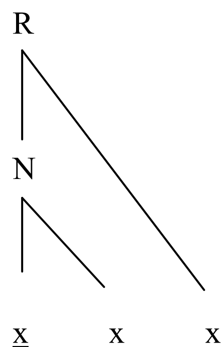
2.8.1. Constituency

The central concepts of GP are constituency and dependency. There is a direct relation between the two: the ordered sequence of skeletal positions that any possible phonological constituent contains forms a domain over which the government holds.

Three constituents are recognized in GP: the Onset, the Rhyme and the Nucleus. As for the “Coda”, it is not given any status in the grammar and it is not part of representation; it is merely a label for the governee in the rhyme. As a result, principles of grammar simply cannot refer to a “Coda constituent”.

The definition of government implies that there can be no superheavy Rhymes in GP. If those were recognized in this theory, the configuration in (8) would arise. In (8), a nuclear dependent position (the non-head position dominated by N) intervenes between the head of N (the underlined ‘x’) and the post-nuclear dependent immediately dominated by the Rhyme. But this configuration violates the strict locality condition on government and is therefore illicit.

(18)



At this point, it will be helpful to review the notion of government.

2.8.2. Government

I briefly present here the *phonological government*, its properties and domains. Government as a phonological relation is the “inverse” of dependency: both terms refer to the same relation that specifies that, in a combination of two units, one unit is the head (governor) and the other is the dependent (governee). GP formalizes government with some specific properties that DP does not have. These are discussed below.

Government is a binary, asymmetric relation between a head and a dependent on a given projection. By definition, government is strictly local and strictly directional. Strict locality is here understood simply as adjacency. Thus, skeletal positions are strictly local (strictly horizontally" local) if and only if they are adjacent on the corresponding tier (namely, the skeletal tier). Furthermore, government is strictly directional in the sense that, for a given government domain (within a constituent or across constituents) and for objects of a certain status (skeletal positions or Nuclei, that is, a specific type of constituent), government has a single, fixed and universal direction.

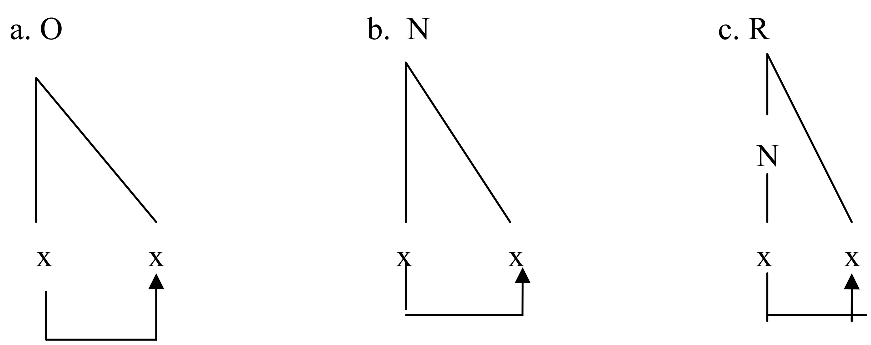
The direct implication for the organization of grammar is that the direction of government is not subject to parameterization in GP.

Another implication of strict directionality is that government has a single direction. In other words, no governing relation is bidirectional in GP: GP does not recognize "mutual dependency" as part of the grammatical apparatus. In this respect, it differs from Dependency Phonology (cf. Anderson and Ewen 1987) which allows a pair of linguistic objects to be each other's dependents.

Strict locality and strict directionality lead to the conclusion that all phonological constituents are maximally binary. Indeed, as proved in Kaye, Lowenstamm and Vergnaud (1990: 199), any ternary constituent would violate either the locality or the directionality condition on government (the "Binarity Theorem").

Government falls into two types: *constituent* government and *interconstituent* government. Each type of government respects both strict locality and strict directionality. First, consider constituent government. Its direction is uniformly left-to-right; in other words, it is invariably head-initial. The inventory of constituent government domains for all phonological constituents is in (19).

(19)

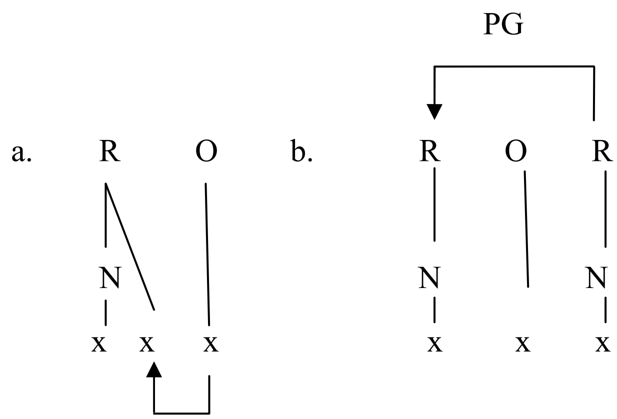


In (19a), the onset head governs the onset dependent. The head of a Nucleus governs its dependent in (19b). In (19c), the nuclear head governs the post-nuclear rhymal dependent. On the other hand, the potential constituent resulting from combining of (19b) with (19c) is ruled out because it violates strict locality (see 2.8.1).

It is a classic observation that two adjacent positions may belong to different constituents. In that case, the members entertain another type of governing relation, namely "interconstituent government".

The direction of government is uniform within a given type of government (constituent or interconstituent), but varies across those. Thus, interconstituent government is right-to-left. This is indicated in (20) where the legitimate configurations involving interconstituent government are described: in (20a), the Onset governs the post-nuclear dependent of the preceding Rhyme; in (20b), the Nucleus on the right (properly) governs the preceding Nucleus.

(10)



The governing relation in (20b) above instantiates a special case of licensing across constituents; it is the Proper Government PG). Being a governing relation, the PG satisfies strict locality. Two neighboring Nuclei are adjacent at the level of nuclear projection, even if their 'timing' positions are not adjacent on the skeletal tier.

The PG has the following defining properties:

(21) *Proper Government*

A ***properly governs*** B iff

(i) A and B are adjacent on their projection;
(ii) A is not licensed.

As (21 ii) stipulates, PG is possible only if the source of PG is not targeted by licensing, which implies the necessity for Government Phonology to incorporate a definintion of licensing and a licensing mechanism of some sort.

PG plays a licensing role in GP by allowing a given position to have no phonetic content. In this way, the occurrence of "empty categories" in the phonological representations is constrained by the phonological analog of the Empty Category Principle (ECP).

(22) *The ECP*

(i) A licensed category receives no phonetic interpretation.
(ii) A domain-final nucleus may be empty in a language which parametrically licenses empty Nuclei.
(iii) A Nucleus is empty if it is 'magically' licensed.[5]

PG has an important implication for the analysis of consonant phonotactics. The availability of PG in the grammar of a given language predicts that a consonant cluster may be

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[5] On Magic Licensing, see Kaye (1992), Snyder (2007: 121-122).

the 'surface result' of two onsets separated by an empty nucleus, which is licensed through PG. It is important to note that there cannot be more than two onsets with an empty Rhyme in between, because a properly governed Nucleus is licensed and therefore may not govern the preceding Nucleus.

2.8.3. Licensing

Constituents contract licensing relations which allow their occurrence in the representations. Constituent licensing follows the well-formedness principles in (23).

(23) (i) Every nucleus must license the preceding onset;
(ii) Every onset must be licensed by the following nucleus;
(iii) Every constituent licenser must dominate a skeletal position.

The principles (23 i, iii) together entail that every Nucleus must dominate (at least one) skeletal position. Interestingly, (23) has no effect on the onset as it is not required to be a constituent licenser. For this reason, some authors recognize "bare onsets", *i.e.* constituents which do not dominate any linguistic object in the representation. However, there is no general consensus on whether they should be recognized (see, among others, van der Hulst and Ritter 1999, Kaye 2000 and Snyder 2007 for different opinions). It is a matter of controversy whether the theory should permit this minimal structure for the onset, as this would enrich the inventory of possible constituents and might lead to overgeneration and the issue of structural ambiguity.

For a skeletal position to be legitimate within any constituent, the Licensing Principle in (24) must be met (cf. Kaye 1990: 306). Furthermore, the post-nuclear dependent and the onset must satisfy (25) and (26), respectively.

(24) *The Licensing Principle*

All phonological positions save one must be licensed within a domain. The unlicensed position is the head of this domain.

(25) *The Coda Licensing Principle*

The post-nuclear rhymal position must be licensed by a following onset.

(26) *The Onset Licensing Principle*

An onset head position must be licensed by a nuclear position.

GP's traditional classification of syllabic relations is not straightforward. Thus, Proper Government is termed "government" But, conceptually, it could rather be considered a form of licensing since what PG does is licensing an empty Nucleus to remain silent.

A different classification of various licensing and governing relations is offered in van der Hulst (2006, 2011: 29-33). This approach chooses licensing as the general notion and takes government to be a structural effect of licensing. A constituent is allowed to branch or to be empty-headed only if it is *licensed* by the following non-empty constituent(s) (inter-constituent licensing).

In this system, the traditional "Proper Government" relation is an instance of the inter-constituent licensing of an empty Rhyme. The traditional "Coda licensing" relation is another instance: the Rhymal constituent is allowed to branch and thus to dominate a "Coda" position. Intra-constituent licensing is the licensing of one member by another *within* the same constituent. A dependent is licensed, that is, allowed to occur within a constituent, only if it receives intra-constituent licensing (the dependency relation) (characterized by a head-dependent asymmetry, see Dresher and van der Hulst, 1998). The GP term for this type of licensing is "intra-constituent government".

With respect to the licensing and structure of the onset constituent, van der Hulst (2011: 30) distinguishes two types of empty onsets: those that dominate a skeletal position and those that lack it. van der Hulst and Ritter (1999: 121-122) suggest that the latter are not relevant to phonological computation at any level; notably, they cannot receive phonetic interpretation. Only constituents having skeletal positions may contract licensing. They further suggest that the invisibility of onsets lacking skeletal positions may be due to the absence of the *head*. (As heads are skeletal positions, the empty onsets which do not dominate any skeletal position are headless).

Note also that a number of proposals were made towards a theory of *licensing inheritance* in Harris (1997). For its development, see Cyran and Gussmann (1999) and Cyran (2010).

2.8.4. The Complexity Condition and possible onsets

Segmental complexity sets an important substantive requirement on the segments whose hosting positions contract a head-dependent relation. This requirement is the Complexity Condition, which a governor must satisfy.

(27) *Complexity Condition*

Let α and β be segments occupying the positions A and B respectively. Then, if A governs B, β must be no more complex than α.

This is referred to as the fundamental head-dependent asymmetry (HDA) in Dresher and van der Hulst (1998): a dependent cannot be more complex than its head. Dresher and van der Hulst argue that this asymmetry holds at all levels, not just the segmental level.

Harris (1994, 1997) calculates the complexity of a segment as the number of "elements" of which this segment is made. It follows from the Complexity Condition that branching onsets universally have a downward complexity slope. Given that liquid segments are less complex than obstruents, the latter can govern the former, which allows obstruent-liquid events to form an onset.

Besides the Complexity Condition, some versions of GP have additional mechanisms that rule out certain sequences as impossible onsets, based on the internal make-up of the segments which compose those sequences. For example, the version of Harris (1994) requires that the two onset constituent members share *at most* one element in their segmental structure. The effect of the condition is that geminates and stop-nasal sequences are not possible complex onsets in GP, as more than one common element is shared by the two onset members for each of those sequences.

Unlike the sonority-based theories such as Clements (1990), the Complexity Condition does not express the requirement on onset members with respect to the steepness of their sonority slope. At the same time, there is some similarity of approach between GP and theories incorporating sonority (within both Onset-Rhyme and moraic models) in that sonority/complexity is not considered as a primitive; rather, it is derived from information about segment structure.

In conclusion, as discussed in section 2.8, Government Phonology is a restrictive parametric theory of the phonological grammar within the Principles-and-Parameters framework, analogous to the theories of syntax. GP is based on constituency and head-dependent relations. The core notion of GP is "government": a binary asymmetric dependency relation which sets a specific complexity constraint on the members that contract it.

3. Criteria for the analysis of complex consonantal events

Recall from the preceding sections that, given a complex consonantal event, three structural analyses are available: the complex onset analysis (1b), the complex segment analysis (1c) and the 'two-onset' analysis (1d).

In this section, I formulate a set of criteria for differentiating between these three analyses: the Sonority Criterion, the Unique Combination Condition, the Phonotactic Condition, the Independent Existence Condition and the Homorganicity Condition.

These statements are of two types. The Sonority Criterion rejects the complex onset analysis for complex events with non-increasing sonority. The Independent Existence Condition uniquely characterizes certain complex events as complex segments. The remaining conditions lead us to *prefer* one particular analysis over others as the most likely one, in the absence of evidence for the alternative analyses.

3.1. The Sonority Criterion

As observed in section 2.1.4.2, the Sonority Sequencing Generalization (SSG) sets restrictions on possible syllable structures (for early work: Sievers 1881, Jespersen 1904, Saussure 1916: 70-95; more recently, Selkirk 1984 and Clements 1990, among others). Here is the version of the SSG due to Clements (1990: 285).

(28) *The Sonority Sequencing Generalization*

Between any member of a syllable and the syllable peak, only segments of higher sonority may occur.

It is reasonable to apply this version of SSG at the UR. Based on the SSG, the following Sonority Criterion can be proposed, which differentiates between complex onsets and complex segments.

(29) *The Sonority Criterion*

If a complex phonetic event is a complex onset, then it respects the Sonority Sequencing Generalization.

The Sonority Criterion entails that if the sonority profile does not increase between the members of a phonetic event, this event is either a complex segment or two onsets with an empty nucleus in between. For example, in the prenasalized events like [mb] and doubly articulated consonants like [kp], sonority does not increase and therefore they have the structure in (1c) or in (1d).

As another example (drawn from Cyran and Gussmann 1999), the events of several types in Polish, given in (30), all violate the SSG and therefore, according to the Sonority Criterion, they are not complex onsets.

(30)	a. sonorant-obstruent events	[rt]ęć	mercury
		[wz]a	tear
	b. sonorant-sonorant events	[ml]eko	milk
		[mn]ogi	numerous
	c. obstruent-obstruent events	[pt]ak	bird
		[kt]o	who
		[gd]y	when
		[db]ać	care

3.2. The Unique Combination Condition

The situation where a language has only one complex event seems to be special.

Let's imagine a language which has only simple events except one, consisting of a obstruent portion followed by a sonorant portion (symbolized as TR).Assume now that this complex event is the only complex onset in this language. If we assume additionally that this language has other obstruent and sonorant segments, than this set of assumptions will lead us to expect that other complex onsets should occur as well. Therefore, this language should have additional complex events besides the given one. Since this is not true in our hypothetical case, it is then unlikely that the complex event is a complex onset.

This argument leads to the Unique Combination Condition in (31) for preferring either the complex segment analysis or a two-onset analysis over the complex onset analysis (provided the language has other obstruent or sonorant consonant phonemes).

(31) *The Unique Combination Condition*

If a phonetic obstruent-sonorant combination is the only complex consonantal event in the language, then it is most likely *that it does not realize a complex onset.*

For example, the Unique Combination Condition can be applied in Malagasy (410) (Maddieson 1984: 338). Malagasy has exactly one complex phonetic event: [ʈɽ]. Following the condition in

(31), [ʈɽ] is a phonetic realization of an underlying complex segment. It must be said that my analysis confirms the analysis in Ségéral and Scheer (2003)[6].

For discussion and applications of the Unique Combination Condition, see Martinet (1939, 1970), Trubetzkoy (1939), Hyman (1975) and van de Weijer (1994).

3.3. The Phonotactic Condition

Consider now a similar situation where the set of complex consonantal events occurring in a language is considerably smaller than the full set of combinations expected to occur as legitimate complex onsets.

Under which conditions may we then conclude that these complex consonantal events are complex segments?

The condition is readily illustrated with the well-known example of Igbo (see Hyman 1975: 96).

All syllable shapes in this language are *CV* (sequences consisting of a single *plain* consonant and a following single vowel) except the phonetic events [kw], [gw] and [ŋw] followed by a vowel. In principle, each of these events could be analyzed as a complex segment (a labialized velar) or as a segment sequence. Note now that the occurrence of [w] in Igbo is restricted to the position after homorganic velars. This phonotactic constraint on dorsal-velar motivates their treatment as complex segment because otherwise complex onset events other than [kw], [gw] and [ŋw] would be expected to occur.

Thus, the velar-glide events in Igbo cannot be complex onsets.

Generalizing this example, the following criterion can be formulated.

(32) *Phonotactic Condition*

A complex consonantal event αβ is likely not to be a complex onset if the set of all complex consonantal events occurring in a language is considerably smaller than the full set of combinations that it is expected to have as legitimate complex onsets ***due to a particular combinatorial restriction*** *on certain segments.*

3.4. The Independent Existence Condition

I propose here the Independent Existence Condition (IEC), which differentiates between the complex segment analysis, on the one hand, and the complex onset analysis and the "two-onset" analysis, on the other. The application of the IEC requires knowledge of phonemic inventories. The idea of the IEC is that if one of the portions of a complex consonantal event is not an underlying segment in this language, the event cannot be a complex onset.

[6] Note that this Malagasy event is characterized as a single phoneme in Maddieson (1984: 338), namely, as a voiceless retroflex affricated trill.

The IEC will determine if a given phonetic event has necessarily the underlying structure of a complex segment or not. For certain languages, the outcome is positive. In these cases, the conclusion is that the complex event in question is a complex segment. For certain other languages, the IEC does not allow to make a decision; in these languages, the complex onset analysis remains a possibility.

For a complex consonantal event in a given language L, there are exactly three possibilities:

(33) (i) both portions are independently occurring segments in L;
(ii) one of the portions is not an independently occurring segment in L, the other is;
(iii) none is a segment in L.

(A “segment” means here an “underlying segment”, not a “phonetic segment”.)

If, in a given language, a complex phonetic event realizes a complex onset or a two-onset configuration, then, clearly, *only* the option (i) is possible because both members of this event must be independent underlying segments of this language. We thus obtain a diagnostic for identifying complex segments:

(34) *The Independent Existence Condition*

For a complex consonantal event in some language, if ***at least one*** *of its members does not correspond to an independently occurring segment, then the entire event corresponds to a complex segment.*

The IEC thus blocks both the complex onset analysis and the double onset analysis if either (33 ii) or (33 iii) apply and, in those cases, necessarily points to the complex segment analysis.

To illustrate the Independent Existence Condition, I will draw on the data from Maddieson (1984), particularly its phoneme charts, containing some information from the UPSID, a database organizing phonemic data from 317 languages selected on the basis of genetic diversity.

All four theoretically available options are actually instantiated in world’s languages.

There are languages which have complex events but lack both portions of those as underlying segments. For example, in Ocaina (805) (Maddieson 1984: 396), the complex event [dz] is found at the phonetic level, but neither /d/ nor /z/ is an independent underlying segment in this language. So, according to the Independent Existence Condition, [dz] is a realization of a complex segment /dz/.

In some languages with complex consonantal events, only the right portion of the event corresponds to an underlying complex segment. For example, Kwak’wala (731) (Maddieson 1984: 379) has [gw] and [xw] and it has /w/ but no /g/ and no /x/. Therefore, /g^w/ and /x^w/ are complex segments in this language.

In some languages with complex consonantal events, only the left portion of the event is a segment in the language. For example, Chipewyan (703) (Maddieson 1984: 369) has [kw], [xw], [ɣw]; it has also /k/, /x/, /ɣ/, but lacks /w/. Therefore, [k^w], [x^w] and [$ɣ^w$] in Chipewyan are complex segments /k^w/, /x^w/ and /$ɣ^w$/. Similarly, Mixtec (728) (Maddieson 1984: 377) has

[kw] and /k/ but no /w/. Here too, we arrive at the same conclusion: [kw] realizes a complex segment /k^w/ in Mixtec. The language Ocaina (just mentioned) has the phonetic event [t^j] and the underlying /t/, but no underlying glide /j/. Therefore, /t^j/ is a single consonant in Ocaina.

Quileute (732) (Maddieson 1984: 379) has the plain and ejective voiceless velar and uvular obstruents as segments. Each of those has a labialized phonetic counterpart. Quileute also has the underlying /w/. In this case, the Independent Existence Condition cannot distinguish between the complex segment analysis and the complex onset analysis as both portions are independently occurring segments.

It is interesting to note that the IEC gives an answer to the analysis of obstruent-glide events which are known to be problematic in a number of cases (see Steriade 1993, as well as Laddefoged and Maddieson 1996).

The table below summarizes the typology of complex events depending on the phonemic status of each portion of the event.

(35)

language	C_1	C_2	*complex segment?*
Ocaina	-	-	complex segment
Chipewyan	+	-	complex segment
Kwak'wala	-	+	complex segment
Quileute	+	+	N/A

As we saw, all four possible situations are attested in the world's languages.

3.5. The Homorganicity Condition

If the members of a given complex consonantal event are homorganic, then it is likely that the event at hand is a single segment as the members of the event may be tightly constrained.

(36) *The Homorganicity Condition*

If the members of a complex event are not homorganic, then this event is either a complex onset or two onsets separated by an empty Rhyme.

In the case of complex onsets there is no homorganicity because of the fact that in complex onsets the properties of segments seem to be complementary (see also the approach in to complex onsets as single feature bundles in Hirst 1986). In the case of double onsets we do not expect homorganicity because if the members of a complex event are dominated by *independent* onset constituents, it is expected that they will display no restrictions at all.
(See, however, Cyran and Gussmann 1999 who show that, in Polish, the attested set of double onsets sequences is smaller than the possible set thereof.)

If the phonetic event is homorganic, for example, affricates like [pf] or [ts], the event cannot for that reason be analyzed as a complex onset.

Note that the Homorganicity Condition is not a sufficient condition for an event to be identified as a complex segment. For example, [k] and [j] in [kj] are both dorsal; however,[kj] is a complex onset, in the traditional view. If [k] and [j] realize /k/ and /j/ (respectively), then they may form a complex onset, as predicted by theories allowing for complex onsets. The relevant evidence would be the existence of a language which contrasts an onset sound [k^j] with a sound sequence [kj]. However, distinguishing between a stop-approximant sequence and a stop with a secondary articulation is often a difficult as a practical matter of experimental phonetic analysis (see Laddefoged and Maddieson 1996 on segmentation).

3.8. Summary

In this section, I formulated several conditions which serve to restrict the set of complex consonantal events so that the complex onset analysis for them is excluded. That is, if a given complex event satisfies at least one of the conditions (29), (31), (32) and (34), then it is not a complex onset.

These conditions involve different kinds of phonological properties: the sonority profile, the uniqueness of an onset complex event, the presence of a specific phonotactic restriction, the phonemic status of individual members in a complex consonantal event.

In the following sections, I will study the behavior of complex consonantal events in phonological processes (rather than static conditions on the events). This inquiry will lead us to a constraint on complex segments (section 5).

4. Reduplication patterns for complex consonantal events

In this section, I investigate reduplication patterns of consonantal events in order to establish how complex events behave under reduplication. A priori, one would expect that whereas complex onsets or double onsets could be broken up in reduplication patterns, this should not be possible when dealing with complex segments, which ought to behave as units. I must add that I am not proposing here a specific formalism to capture reduplicative processes.

The sections 4.1-4.3 describe reduplication patterns found in three languages: Gothic, Sanskrit and Klamath. Finally, section 4.4 classifies the complex consonantal events in terms of what member is copied in a given language (the head member, the dependent member, or both).

4.1. The reduplication in Gothic

In Gothic (Eastern Germanic), consonant events in the stem-initial onsets of Gothic strong verbs follow different patterns of reduplication depending on the nature of the event's members. These reduplication patterns are presented in the examples in (37-42) drawn from Wright (1910).[7] The examples are organized by type of stem-initial event.

[7] The vowel in the reduplicative prefix is consistently /e/.

(37)	*Infinitive*	*Preterite Sg.*	*gloss*
	a. hetan	hehet	call
	b. le:tan	lelo:t	let
	c. haldan	hehald	hold
(38)	a. aukan	eauk	increase
	b. af-ekan	af-eek	deny
(39)	a. fresan	fefres	tempt
	b. gre:tan	gegro:t	weep
(40)	xwo:pan	xwexwo:p	boast
(41)	a. skedan	skeskeθ	divide
	b. ga-staldan	ga-stestald	possess
(42)	slepan	seslep	sleep

The following observations can be made with respect to (37-42).

A simple consonant in the stem-initial onset is copied entirely (37). There is a systematic contrast between the reduplication patterns in (39) and (41): in obstruent-sonorant events, the obstruent is copied while the following sonorant is not (39); strident-obstruent events are copied entirely (41). Note also that Gothic [x^w] (in principle analyzable as a labialized consonant or as a sound sequence) undergoes full copy (40), like simple segments in (37). Strident-sonorant events undergo partial reduplication: thus, in (42), only [s] is copied, whereas the following sonorant is not. So, strident-sonorant events and events consisting of a non-strident obstruent plus sonorant behave in the same way. (This patterning is expected because stridents are obstruents).

It would seem then that the obstruent-sonorant cases in (39) and (42) undergo partial copy and thus behave as complex onsets, while the cases in (40) and (41) undergo full copy and thus behave as units.

The unitary behavior of *s*-obstruent is specifically interesting since it implies that *s*-obstruent clusters should be analyzed as complex segments as proposed in Ewen (1982) and van de Weijer (1994). We will see that this status of such events is not universal, however.

4.2. Sanskrit Perfect reduplication

In this section, I examine the behavior of complex consonantal events under Perfect reduplication in Sanskrit.

For Sanskrit stems that begin with an obstruent-sonorant event, the corresponding surface reduplicant begins with an obstruent, without the sonorant (43).[8] The same is true of the stems that begin with a strident-sonorant event: the reduplicant begins with the strident, without the sonorant (43).

(43) *obstruent-sonorant* (Whitney 1889: 222-223)

Infinitive	*Perfect Stem*	
a. prac^h	paprac^h	ask
b. grab^h-	ɟagrab^h	seize

The obstruent-sonorant events behave as in Gothic.

(44) *strident-sonorant* (Whitney 1889: 223)

a. smr̥	sasmr̥	remember
b. sna:	sasna:	bathe
c. çliṣ	çiçliṣ	burn
d. çri	çiçri	stick
e. sru	susru	flow

Strident-sonorant events reduplicate, again, as in Gothic.
The reduplicative pattern for strident-obstruent events is illustrated in (45).

(45) *strident-obstruent* (Macdonnell 1926: 87, Whitney 1889: 223, Steriade 1988)

a. stu	tuṣṭu	praise
b. st^{h}a:	tast^{h}a:	stand
c. skand	caskand	leap
d. çcut	cuçcut	trickle
e. sk^{h}al	cask^{h}al	deviate

[8] Steriade (1988) develops a different approach to reduplication (the "full copy approach"), in which obstruent-sonorant event always undergo full copy first. However, at a later point in the derivation, the sonorant does not match the reduplicative template, which results in its absence in the output forms.

f. tan tastan thunder

So, Sanskrit and Gothic treat strident-obstruent events differently. In Gothic, the event is copied as a whole; in Sanskrit, only the obstruent is copied. For strident-sonorant and obstruent-sonorant events, the leftmost member is copied in both.

As described in Steriade (1982, 1988), if a complex consonantal event contains a strident, the event's (only) member that surfaces in the reduplicant is the least sonorous one. Strident-obstruent events are structurally ambiguous as their behavior varies with the language. As discussed in the preceding section, they behave as a complex segment while they do not behave as a unit in Sanskrit. According to the Sonority Criterion, they cannot be complex onsets. This suggests that these events should either be analyzed as complex segments, or as a sequence of segments in more than one constituent. In the latter case, the possibilities include a double onset analysis and the analysis based on assumptions on the approach to *s*C in Kaye (1992). Both treat the s-obstruent as heterosyllabic.

4.3. The distributive reduplication in Klamath

Klamath (Plateau Penutian subgroup of Penutian) is a language of the Klamath tribe of Southern Oregon. One salient phonological feature of Klamath is its rich set of stem-initial consonantal events.

I draw on Barker (1963, 1964), two major reference works on Klamath (a gram-mar and a dictionary), and also use the survey of the onset transfer in Fleischhacker (2002).

Klamath has both distributive and intensive reduplication.[9] For both types, the range of meanings is wide, according to Barker's description. Barker (1964:111) characterizes the meaning of distributive reduplicative prefix as "distributive action".[10] Only the distributive reduplication is studied in this paper.

The reduplicative patterns in Klamath given below are arranged by type of stem-initial phonetic event[11].

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[9] In Barker's approach, reduplicative morphemes are realized, at the morphophonemic level, as the morphophoneme | r || or ||e||, or a specific combinations of those. Barker (1964: 111-112) classifies the distributive reduplicative morpheme in the prefix class 1pv. Intensive morphemes belong to the class 9psv; see Barker (1964: 143).

[10] According to Barker (1964:111), "distributive action" involves either one:

(i) An action by a single actor upon distributive objects; (ii) An action by a single actor performed distributively upon a single object over a period of time; (iii) An action by distributive actors upon a single object; (iv) An action by distributive actors each upon his own object; (v) An action by distributive actors upon distributive objects.

[11] Below, I give Barker's *phonemic* forms. I replace the non-standard symbols by the current IPA ones, except very few, mostly for typographical reasons. The choice of IPA equivalents is based on the descriptions of the value of symbols in Barker (1964: 21-31, 39-40). The special (non-standard) symbols employed in this section are: G for the plain voiced uvular stop, L for the voiceless alveolar lateral, Y and W for the voiceless palatal and labial-velar approximants, respectively. Also, ' is used after a number of consonants to indicate ejectivity, similarly to Blevins (2001: 467). I will not make a principled phonological analysis of ejectives and glottalization; cf. the work by Barker and Blevins.

4.3.1. A single consonant

When a word with a stem-initial simple consonant in prevocalic position is reduplicated, it is copied identically.

(46) a. /powetga/ pulls out of a socket /popwetga/ *(d.)* pulls an object out of a socket

b. /loq/ grizzly bear /lolq'a:k/ *(d.)* little grizzlies

c. /so:tʃa/ lights a fire /soso:tʃa/ *(d.)* light a fire

Klamath has several other processes which interact with reduplication and syllabification and which are only triggered by distributive reduplication (not the intensive one). In particular, the first vowel of the stem may undergo deletion or reduction (see ter Mors *ms*, Kimper 2007, Frampton 2009: 40-43). I do not deal with these processes here.

4.3.2. Obstruent-obstruent events

Obstruent-obstruent sequences undergo full copy in Klamath. Thus, the stem-initial stop-obstruent events are copied entirely, be they stop plus fricative (47a), stop plus affricate (47b) or two-stop (47 c, d) events.

(47) a. /ptʃik'lGa/ brushes someone's hair /ptʃiptʃak'lGa/ *(d.)* brush the hair

(from /ptʃik'/ brush)

b. /tqiqʟa/ puts an elbow on a surface /tqitqaqLa/ *(d.)* put an elbow on

(from /tqiq/ act with the elbow)

c. /tq'op'o:/ thumb /tq'otq'apw'a:k/ *(d.)* little thumbs

4.3.3. Sonorant-obstruent events

Klamath also has sonorant-obstruent events stem-initially. The pattern of reduplication for liquid-obstruent is illustrated in (48a) and that of nasal-obstruent in (48b-f).[12]

(48) a. /lto:q'a/ is spotted /ltolto:q'atk/ *(d.)* spotted

(from /lto:q'/ be spotted)

b. /mpet'lGa/ sinks /mpempat'lGa / *(d).* sink

[12] I found no reduplicated forms with stem-initial glide-obstruent events in Barker (1963, 1964).

c. /msas/ prairie dog /msamsk'a/ *(d.)* little prairie dogs

d. /ntʃ'ama:stʃwo:la/ wipe off someone's hair

/ntʃ'antʃ'ma:stʃwo:la/ *(d.)* wipe off someone's hair

(from /ntʃ'ama:s/ wipe)

e. /ndetʃgi/ be shy /ndendatʃgi/ *(d.)* are shy

f. /nteys/ bow /ntenti:ʔa:k/ *(d.)* little bows

So, the sonorant-obstruent sequences that occur stem-initially in Klamath also all undergo full copy. The pattern is not dependent on the category (liquid or nasal) and on the quality of the sonorant member.

4. 3.4. Sonorant-sonorant events

Glide-sonorant sequences also undergo full copy.

(49) /wlitʃkanga/ goes around zigzag /wliwlatʃkanga/ (*d.)* go around zigzag

So, sonorant-sonorant sequences also undergo full copy in Klamath.

To sum up, I have shown in the sections 4.3.2-4.3.4 that obstruent-obstruent, sonorant-obstruent and sonorant-sonorant phonetic events in Klamath reduplicate in a single way; they all undergo full copy. Additionally, they cannot be analyzed as complex onsets because in that case the Sonority Criterion would be violated.

The next section shows that the potentially wellformed complex onsets (i.e. obstruent-sonorant) do not undergo full copy.

4.3.5. Obstruent-sonorant events

Below, I examine the behavior of obstruent-sonorant events under reduplication. As I will show, the productive reduplication process has a single pattern followed by all obstruent-sonorant events. The exceptions to this pattern are very limited in number and they are nearly all listed here. The obstruent-liquid events are discussed in section 4.3.5.1, the obstruent-nasal events are discussed in section 4.3.5.2.

4.3.5.1. Obstruent-liquid events

Stem-initial obstruent-liquid sequences virtually always undergo partial copy, as exemplified in (50).

(50) a. /tʃ’lekLa/ puts a massive object down on top

/ tʃ’etʃ’lakLa/ *(d.)* put a massive obj. down on

b. / tʃ’leja/ gives a massive object /tʃ’etʃ’li/ *(d.)* give

Importantly, Fleischhacker (2002: 2) makes the following observation:

> *“stop+sonorant (TR) clusters are simplified in some reduplicated forms, with copy of the stop only. In other reduplicated forms, TR is copied fully, and there is at least one case of free variation between full copy and simplification of TR”*[13].
> (Fleischhacker’s examples omitted).

Thus, Fleischhacker (2002) does not identify explicitly the specific type(s) of sonorants (R) that are copied together with the stop (T) in some reduplicated forms (she only gives examples of stop-glide and stop-nasal) and makes no clear statement as to whether the full-copy pattern is available systematically. However, as I will show, full copying of obs+son events is the exception to the rule.

The near-minimal pair in (51), repeated from Barker (1964:82), suggests that Klamath might have more than a single regular, productive pattern for obstruent-liquid, obstruent-nasal or both.

(51) a. /tʃ’litʃ’latGa/ punctures and peels *d.* objs. with the fingernails
b. /tʃ’etʃ’latga/ takes *d.* objs. of amorphous shape out of a container

But, regarding the case of obstruent-liquid events that follow the full-copy pattern, my search of the *Klamath Dictionary* (Barker 1963) shows that they are very few. Almost all relevant forms are listed in (52):

(52) a. /tʃlo:q’a/	slippery		
/tʃlo:q’/	be slippery	/tʃlotʃlo:q’atk/	*(d.)* slick
b. /tʃ’lawsYe:n’a/	gropes around inside	/tʃ’latʃ’lo:sYe:n’a/	*(d.)* grope inside
c. /qli:pa/	mink	/qliqli:paʔa:k/	*(d.)* little mink
d. /kla:li:na/	scuffs one’s foot or leg	/klakla:li:na/	*(d.)* scuff
(from /kla:/ scuff)			
e. /qlin/	choke	/qliqlan/	*(d.)* choke (cf. Zoll 2002)

Therefore, “full copy” is not productive for Klamath obstruent-liquid events. Rather, Klamath simply has a handful of exceptions to “partial copy”, which is the only productive pattern for reduplicating stems which begin with an obstruent-liquid event. I suggest that the “full copy” is not part of grammatical knowledge available to Klamath speakers and that the

[13] I add that I omit Fleischhacker’s examples at this point., as my focus here is on the claim.

reduplicated forms in (52) must be *learned* as separate lexical items, rather than derived by the morphology.

4.3.5.2. Obstruent-nasal events

For most Klamath forms, when a stem beginning with an initial obstruent-nasal event is reduplicated, the obstruent is copied whereas the nasal is not. This is illustrated in (53) for various events using data from Barker (1963).

(53) a. /gmoča/ get old /gogmča/ *(d.)* get old
b. /gmaja/ teases /gagmi/ *(d.)* tease
c. /tʃ’moga/ gets dark /tʃ’otʃ’mga/ *(d.)* get dark
d. /tʃ’naw/ reed /tʃ’atʃ’no:ʔa:k/ *(d.)* little reeds
e. /dmesga/ deprive /dedmasga/ *(d.)* deprive
f. /pni/ wild onion /pipnaʔa:k/ *(d.)* little wild onions
g. /dmetʃ’a/ washes (clothes) /dedmattʃ’a/ *(d.)* wash
(from /dmetʃ’/ wash (clothes))
h. /qmaGa/ searches /qaqmGa/ *(d.)* search
(from /qmaG/ search)

Examination of Barker (1963, 1964) shows that virtually all stems beginning with an obstruent-nasal sequence reduplicate in this, and only this, way. Again, only a few Klamath forms with stem-initial obstruent-nasal sequences undergo full copy:

(54) a. /p’nana/ burries /p’nap’na/ *(d.)* bury
(from /p’nan-/ bury)
b. /pniw/ blow
/pniwpč’a/ blows out a light /pnipno:pč’a/ (*d.)* blow out a light[14]
c. /k’mokta/ sticks on (bits of fur) /k’mok’makta/ *(d.)* stick on
(/kmok/ stick on (bits of feathers))
d. /qme:Wtgi/ stops gradually /qmeqme:Wtgi/ *(d.)* stop gradually
(from /qme:W/ stop gradually (of reverberations))

Very few forms, apart from those in (54), follow the full-copy pattern and thus the forms in (9) are exceptional.
Additionally, Klamath has two reduplicated forms in (55) from a single stem.

(55) a. /qniy’a/ has an erection

[14] There is a handful of other forms derived from stems containing the same root and additional affixes.

b. (i) /qniqny'a/ *(d.)* have an erection

(ii) /qiqny'a/ *(d.) same meaning as* (55a)

The forms (55b i, ii) have the same meaning and are minimally distinct formally. So, as observed in Barker (1964: 85) and in Fleischhacker (2002: 2), (55b i) and (55b ii) are in "free variation".

Free variation between reduplicated and non-reduplicated "obstruent-nasal" forms would pose a problem for predictability of reduplication. However, (55) is not sufficient evidence for non-predictability as (55) seems to be the only case, according to my inspection of the data in Barker (1963, 1964).

It is clear from the above that the only productive reduplication pattern for stems that begin with an obstruent-nasal event is partial copy where the obstruent is copied whereas the dependent is not.

Summarizing the section 4.3.5, obstruent-liquid and obstruent-nasal events both undergo partial copy in Klamath: only the obstruent part is copied. Also, the identical behavior of obstruent-liquid and obstruent-nasal events under reduplication provides evidence that they form one phonological class in Klamath**.**

4.3.6. Strident-consonant events

This section describes the reduplication patterns characterizing different types of [s]-consonant events and then groups them depending on their behavior. The question is then whether different strident-consonant events behave in the same way or if their behavior varies depending on the specific event type (or even on the individual event) within the general class of strident-sonorant events. I will begin with [s] plus obstruent and follow up with [s] plus sonorant.

The [s] plus stop (56) and [s] plus affricate (57) undergo full copy.

(56)	a. /sdolj/	advise	/sdosdli/	(*d.)* advise
	b. /stin-/	suspend	/stistanta/	*(d.)* suspend on
	c. /sk'itʃ'a/	nags	/sk'isktʃ'a/	*(d.)* nag
	(from /sk'itʃ'/	nag)		
	d. /sqeqkyamna/	hugs with the legs	/sqesqaqkyamna/	(*d.)* hug with the legs
	(from /sqeq'/	straddle)		
(57)	/stʃiq'daqn'a/	bridles (a horse)	/stʃistʃaqdaqn'a/	(*d.)* bridle

Since all the [s]-obstruent events in Klamath reduplicate entirely, the set of strident-obstruent events is a single class in Klamath from the point of view of reduplication. The question now is if events consisting of an [s] plus a non-obstruent consonant belong to the same class as the [s]-obstruent events.

The effect of reduplication on stem-initial [s]-liquid is shown in (58) and on stem-initial [s]-nasal events in (59).

(58)	a. /sleya/	gives a cloth-like object	/slesli/	(*d.*) give a cloth-like object
	b. /slitʃlGa/	ties up (a horse, a shoe)	/slislatʃlGa/	(*d.*) tie up
	c. /sleʔa/	see	/slesleʔa/	*(d.)* see
	(from /sleʔ/ see)			
	d. /sl'aba/	blooms, blossoms	/sl'aslba/	*(d.)* bloom

When reduplicated, stem-initial [s]-nasal events always undergo full copy.

(59)	a. /smo:k'/	tan a hide	/smosmo:k'a/	*(d.)* tan a hide
	b. /snitʃi:q'/	fry	/snisntʃi:q'a/	*(d.)* fry
	c. /snolo:k'a/	threatens, warns	/snosnlo:k'a/	*(d.)* threaten, warn
	d. /sn'oG/	catch, hold	/sn'osnGa/	*(d.)* catch, hold

It is clear from comparing (58) and (59) that strident-liquid events and strident-nasal events follow the same reduplicative pattern in Klamath, namely full copy. Also, they all reduplicate like strident-obstruent events in (56-57). We thus see that all strident-consonant events form a single class based on their reduplication pattern.

At the same time, they pattern differently from other obstruent-sonorant events. This difference is remarkable in that, [s] being an obstruent, [s]-sonorant events form a subset of the set of all Klamath obstruent-sonorant event and therefore they are expected to share their reduplicative pattern with the other obstruent-sonorant events. Instead, strident-sonorant events pattern together with strident-obstruent events and other events different from obstruent plus sonorant.

4.3.7. A summary of Klamath reduplicative patterns

The reduplicative patterns for different types of complex consonantal events are summarized in (60).[15]

(60)	*non-reduplicated form*	*reduplicated form*
	TRV	**T**VTR(V)
	TTV	**TT**VTT(V)
	RTV	**RT**VRT(V)
	RRV	**RR**VRR(V)
	sCV	**sC**VsC(V)

[15] T stands for an obstruent, R for a sonorant. The copied material in the reduplicant is bolded.

Thus, the complex consonantal events in Klamath fall in two classes based on their reduplicative behavior: the obstruent-sonorant (except strident-sonorant) events and all the rest.

What my research has shown is that not all complex events behave the same. That leaves open how these events are to be analyzed. My proposal is that obstruent-sonorant events (except strident-sonorant) are analyzed as true complex onsets, while all other clusters (including strident-sonorant) are "double onset" clusters. The reduplication of the latter is accounted for by assuming that that the reduplicative prefix is CVCV and that reduplication copies onset heads scanning the stem left-to-right (van der Hulst 2010, pers. comm.). Under these assumptions, the consonant following the obstruent-sonorant event should be copied but it is not. An additional constraint is needed then that blocks copying of the second onset head. Observe that it is blocked precisely if the first onset head has a dependent, that is, if it occurs in a complex onset. I will not formalize this analysis here.

4.4. Summary and conclusions

The typology of the complex consonantal events under reduplication across the three languages studied in section 4 is presented in the table (61) below.

(61) *A typology of consonantal events under reduplication (in Gothic, Sanskrit and Klamath)*

Event	Gothic		Sanskrit		Klamath	
Reduplicant	**Both**	**One**	**Both**	**One**	**Both**	**One**
OL		H		H		H
ON						H
sL		H (str)		H (str)	Both	
sN				H (str)	Both	
sO	Both			H (O)	Both	
C^G	Both					
OO					Both	
SS					Both	
SO					Both	

The cross-linguistic comparison of the reduplicative patterns for the events at issue and the study of the peculiarities of reduplication for different phonetic events within a given language lead to the following conclusions:

(i) The events fall into two classes: those that undergo full copy and those that undergo partial copy. In the “partial copy” class, the only pattern is the “head-only” copy (assuming a heterosyllabic analysis for sO in Sanskrit).

(ii) For obstruent-sonorant events, only the head is copied in all three languages.

(iii) In Klamath, obstruent-sonorant events are the only ones to follow the head-only pattern. All other consonantal events follow “full copy”.

(iv) In Sanskrit, all complex consonantal events undergo partial copy.

(v) Gothic and Sanskrit treat strident-sonorant events in the same: only the strident is copied. However, they differ in their treatment of strident-obstruent events: in Sanskrit, only the obstruent member is copied; in Gothic, these events are copied entirely.

(vi) In Gothic, [x^w] is copied entirely: both the labialization and the obstruent are preserved. So, Gothic treats [x^w] and strident-obstruent events in the same way.

(vii) In Klamath, unlike Gothic and Sanskrit, strident-sonorant events undergo full copy.

These findings have implications not only for the fact that not all complex events are treated the same, but also for how the differences in behavior can be related to specific structural analyses (as complex segments, true branching onsets and double onset sequences).

Based on the reduplicative typology above, the next section will give a new direction to the issue of the structural analysis of complex consonantal events. I will propose an approach to structural analysis that involves the “structural depth” of phonological rules. What this means is that the specific analysis of a complex event will make a prediction regarding how that event can be accessed by phonological rules, given that the locality constraints on accessibility are formulated. As I will show, this angle offers us a new criterion for choosing between competing analyses besides the criteria discussed in section 3.

5. Structural Depth and phonological rules

This section relates the analysis of complex consonantal events to the accessibility of the event’s head. I will propose here the Complex Onset Criterion and the Head Constraint. I will then introduce Vertical Locality as the structural depth at which phonological rules are allowed to operate on syllabic representations and will describe the difference between complex onsets and complex segments in these terms.

5.1. The Complex Onset Criterion and the Head Constraint.

Phonological theories equipped with a dependency-based formalism provide an insight into the structure of linguistic units and allow an insightful account of a number of linguistic phenomena (see, *e.g.*, Anderson and Jones 1974; Anderson and Ewen 1987; Kaye, Lowenstamm and

Vergnaud 1985, 1990; van der Hulst and Ritter, 1999 a, b; van der Hulst, 2011). Since the head is the core ingredient of linguistic structure, one can expect that the way in which the head of a given unit behaves, will reveal the status of that event. More specifically, I propose that the *independent variation* of the head (independently of the rest of the unit) under a phonological process reveals the underlying structure of that unit (*viz.*, a segment or a syllabic constituent).
Based on the behavior of complex consonantal events under reduplication (see section 4.4), we can identify two major reduplicative patterns: the copy of the entire event ("full copy") and the "head-only" copy. This leads me to propose the following criterion:

(62) *The Complex Onset Criterion (COC)*

If there is a phonological rule that affects the head of a given event without affecting the dependent, then this event has the complex onset structure.

To illustrate, the head of obstruent-sonorant events in Gothic, Sanskrit and Klamath is copied under reduplication while the dependent is not. We conclude then that obstruent-sonorant events are complex onsets in these languages.

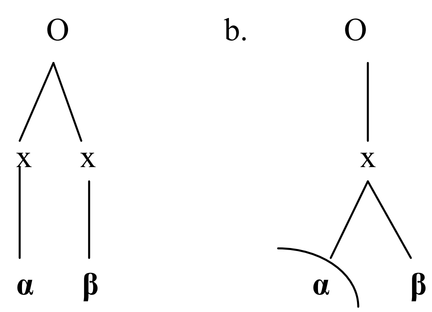
If we restrict ourselves to single onsets, then the COC entails that for complex segments, there is no phonological rule that would access the head of the event without accessing the dependent.

(63) *The Head Constraint (HC)*

No phonological rule may access the head of a complex segment.

Following the Head Constraint, the available rules that access the event will either access it as a whole or only access the dependent. This means that, in a complex onset (64a), the head may be targeted by a phonological rule, while *in a complex segment the head may not be targeted without the dependent being targeted* (64b).

(64) a. b.



So, complex onsets differ from complex segments with respect to the *vertical accessibility* of the head. Let us call this property *Vertical Locality*. As we see, Vertical Locality describes the structural *depth* at which phonological rules are allowed to operate (on locality and depth, see Dresher and van der Hulst 1998).

Vertical Locality can be considered as a type of locality on a par with "horizontal locality" (which characterizes the presence or accessibility of elements in the domain, which spans horizontally). Issues of locality have recently been invoked in accounting for phonological processes. In particular, horizontal locality has been discussed in relation to harmony processes in Nevins (2010) and Mailhot and Reiss (2007). The key proposal of Nevins (2010) is that harmony (including vowel harmony) results only if the application of the Search and Copy applies respecting (relativized) horizontal locality (Nevins 2010: 15, 70).

So, rules cannot freely access the complex segments, unlike complex onsets: they are allowed to access the dependent only or the segment as a whole. The latter possibility seems to be the only way in which *phonological* rules may access the complex segment. They thus display *segmental integrity*. Under this hypothesis, all the rules that have access to the internal structure of segments (in terms of features or elements) are *phonetic* rules. This predicts that the rules that simplify complex segments are "across-the-board' and exceptionless.

The investigation of this hypothesis, however, lies outside the scope of the present paper; I will investigate it in the next project.

5.2. Summary

I proposed in section 5 that the analysis of complex phonetic events in the onset depends on the distinct ways in which phonological rules may operate on onset structure. This idea is captured in the Complex Onset Criterion and the Head Constraint.

The empirical ground for both has been the description of the patterning of complex consonantal events under reduplication in Gothic, Sanskrit and Klamath. In the next section, I shall provide independent support for the COC and the HC by investigating the patterning of complex consonantal events under other phonological processes than reduplication.

6. The Complex Onset Criterion and the Head Constraint: independent support

In this section, I go beyond the original data in section 4, to provide evidence from other phonological processes than reduplication, in support of the Complex Onset Criterion and the Head Constraint.

The Head Constraint and the Complex Onset Criterion are logically equivalent (for events occurring in single onsets). Therefore, if the COC holds, then the HC also holds. This point is important because, rather than providing negative evidence for (63) (for it seems difficult to show empirically that *no* rule exists), we can provide positive evidence for (62).

The pieces of evidence I will offer involve various types of processes: they differ in their effect (alternation or deletion) and in their status with respect to time (synchronic or diachronic processes). Despite their differences, these processes can be captured by a single type of formal phonological rule which consists in element (de)association, as discussed in section 6.2.

6.1. Head deletion: obstruent-liquid events in Leon Spanish

Firstly, in the history of Leon Spanish (Central Spain), /f/ deleted and as a result [fl] was simplified to [l]. This is illustrated by the data in (65) drawn from Pidal (1904: 126).

(65) *Latin* *Spanish* *gloss*

flaksidu	lasjo	“lacio”	flabby
flaginu	lajno	“Laino”	(a proper name)
flaviana	lavjanə	“Laviana”	(a proper name)

Also, [g] deleted in [gl] in Leon Spanish (Pidal 1904: 127).[16]

(66)

Latin	*Spanish*	*gloss*
glandula	landre	acorn
glirone	liron	marmot
glatire	laðir	bark

In addition, there is evidence that, in Leon Spanish, word-initial /pl/ and /kl/ seem to have shared the fate of /fl/ and /gl/. As noted in Pidal (1962: 71), some ancient documents written in Leon Spanish have /l/ in place of an onset obstruent-liquid cluster present earlier in the history of Spanish. Indeed, Pidal (1962: 71) remarks that ancient documents written in Leon Spanish use a single “l” in place of the clusters.[17]

These examples show head deletion in Leon Spanish for [fl], [gl], [pl] and [kl]. If the COC is correct, these events correspond to complex onsets since reference is made to the head (which is deleted).

6.2. Head change: Stop-sonorant events under Gorgia in Florentine Italian

I discuss here the phenomenon of “gorgia toscana” (Castellani 1960, Giannelli and Savoia 1978, Marotta 2006, Brun-Trigaud and Scheer 2008), which involves the synchronic spirantization or deletion of the head of onset events characteristic of Tuscan Italian.

The Italian variety considered here is Florentine Italian. In Florentine Gorgia, the voiceless stops /p t k/ are either spirantized or deleted. If spirantized, /p/ gives [ɸ], /t/ yields [ɵ] or [h], and /k/ yields [x]or [h]. The environment for gorgia is the intervocalic position word-internally as well as across the word boundary if the preceding word ends in a vowel or if it is deleted.

[16] Pidal (1904) notes that there is just a handful of exception words which all belong to the ‘learned’ lexical stock (as opposed to ‘popular’).

[17] Pidal (1962: 71) writes: “lo general en los textos antiguos es la *ll*- como en castellano, o simple *l*: *lorar, leno, luuia, lamar, losa* clausa. “ (Pidal 1962: 71)

(67)

context	Italian	Florentine	gloss
V#___	le korna	le horna	the horns
	la kas:et:a	la xas:et:a, la as:et:a	the box

Gorgia also affects /p t k/ followed by a liquid or a glide in the same environments.

(68)

context	Italian	gloss	Florentine	gloss
a.V__{L,G}V	piɛtra	stone	piɛθra	stone
b.V#__{L,G}V	kwɔʃe	cooks	la lo hwɔʃe lɛi	he cooks it
	kwat:rini	money	i xwat:rini	the money
	kreðe	(he) believes	e ʃi hreðe ɸoxo	he barely believes it
	tiene	keeps	e lo θjene ŋ kasa	and keeps it at home
	tiene		e lo jene ŋ kasa	(same meaning)
	preso	taken	el ano ɸreso	she has taken it

The examples in (67, 68) are from Giannelli and Savoia (1978) and Marotta (2006:157).

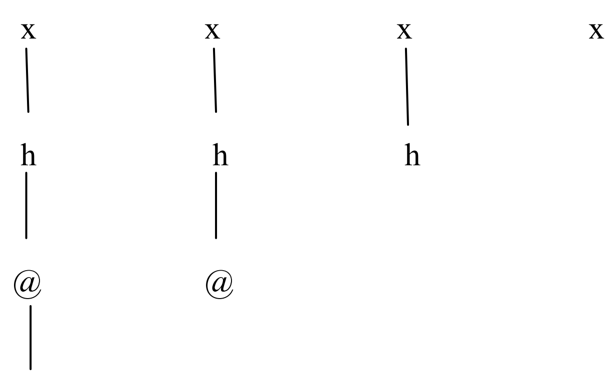
I assume the Standard Italian forms in (67) and (68) to be the basic forms and I suggest that Florentine pattern of spirantization and deletion is accounted for by a phonological rule operating on element structure of segments (Kaye, Lowenstamm and Vergnaud 1985) in the way given in Bafile (1997).

The rule simplifies the target stops by deassociating an element in their underlying representation. The leftmost part of the representations in (69a-c) displays the structure of the velar, dental and labial voiceless stops subject to gorgia, respectively. and of the corresponding results of gorgia. In (69a), (69b) and (69c), every following complex segmental expression from left to right has one element less than the preceding expression. At each step, we get a correct output.

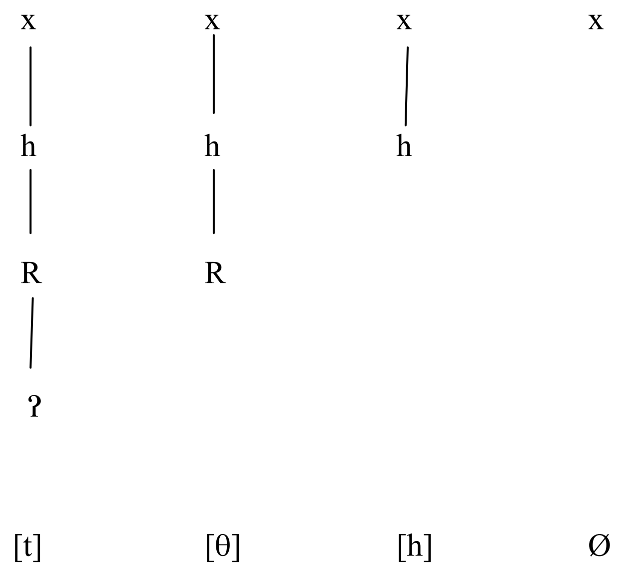
The structures presented below have been proposed in Bafile (1997: 34), along the lines of the model in Harris (1994) and Harris and Lindsey (1995).

(69) *The fate of voiceless stops in gorgia*

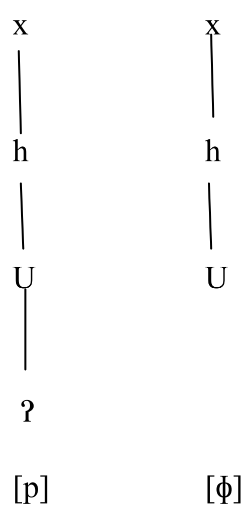
(a) *The fate of the velar stop in gorgia*



(b) *The fate of the coronal stop in gorgia*



(c) *The fate of the labial stop in gorgia*



The elements occurring in the segmental representations in (70) above receive a phonetic realization as proposed in Harris and Lindsey (1995) and Bafile (1997).[18]

[18] I will not discuss here the phonetic *implementation* of the phonological elements in the acoustic signal; this is a different question (albeit interesting in its own right).

(70) *Interpretation of elements*

Element	Type of interpretation	
	in combination	autonomous
Oral		
|R|	coronality	[t]
|U|	labiality	[u]
|@|	velarity	[ə]
Laryngeal		
|ʔ|	occlusion	glottal stop
|h|	noise	glottal fricative

Thus, under the analysis of Tuscan spirantization above, the head (stop) of stop-liquid and stop-glide phonetic events is targeted by a phonological rule (whereas the liquid or glide is not changed).

7. Conclusion

This paper is a study of onset structure with a focus on complexity. Three analyses of onset complex events are available in Government Phonology: a complex onset, a complex segment in the onset and two onsets separated by an empty nucleus.

The static conditions for differentiating between these analyses are given in section 3. These statements are of two types. The Sonority Criterion rejects the complex onset analysis for complex events with a non-increasing sonority profile. The Independent Existence Condition uniquely characterizes certain complex events as complex segments. The Unique Combination Condition, the Phonotactic Condition and the Homorganicity Condition lead us to prefer one particular analysis as the most likely. Together, these conditions serve as a guideline to either selecting a unique analysis or to narrowing down the choices to two possibilities by excluding one.

Section 4 describes and compares the reduplication patterns of consonantal events in three languages: Gothic, Sanskrit and Klamath. Based on the cross-linguistic typology of these patterns summarized in the table (71), two reduplication patterns, “full copy” and “head-only copy”, are identified. This leads me to propose that the underlying structure of an event is revealed by the “independent variation” of the head. This idea is formally captured in the Head Constraint.

The difference between complex segments and complex onsets is thus not only structural. It also concerns the way in which rules apply to representations. In section 5, the Head Constraint is proposed, which prohibits phonological rules from accessing the head of a complex segment. So, complex onsets differ from complex segments with respect to Vertical Locality: the structural *depth* at which phonological rules are allowed to operate.

In section 6, I provide independent support for my claim from the patterning of complex consonantal events in Florentine Italian and Leon Spanish under other phonological processes than reduplication.

This work has led to the following conclusions.

First, it leads to the structural analysis of complex consonantal events in the five languages that have been studied in this paper. This analysis is given in the table in (71) below. By applying criterion (62) to a complex consonantal event, given a phonological rule that targets its head (see the table in (61) in section 4 and section 6), we conclude that the event realizes a complex onset. The analysis of events indicated as complex segments (“CO”) or as double onsets (“OO”) in the table is discussed in section 4.

(71) *Cross-linguistic analysis of complex events by event type*

	Language				
Event	Gothic	Sanskrit	Klamath	Florentine	Spanish
OL	CO	CO	CO	CO	CO
ON			CO		
sL	CO	CO	OO		
sN		CO	OO		
sO	CS	OO	OO		
C^G	CS				
CG				CO	
OO			OO		
SS			OO		
SO			OO		

Second, as concluded in section 5, complex onsets and complex segments differ in Vertical Locality: rules cannot freely access the complex segments, unlike complex onsets: they are allowed to access the dependent only or the segment as a whole. Accessing the entire segment seems to be the only way in which a complex segment may be accessed by a *phonological* rule. In that way, complex segments are characterized by the property of *Segmental Integrity*. This idea lead**s** to the following hypothesis:

(72) *All the rules that have access to the internal structure of segments (in terms of features or elements) are phonetic rules.*

This then predicts that the rules simplifying complex segments should be "across-the-board' and exceptionless. This prediction seems empirically testable. I expect to investigate the correctness and further implications of this hypothesis as part of a larger study of locality in phonology.

Third, the perspective on phonological rules that singles out the accessibility of the event's head allowed us to answer the question put in Lowenstamm (2003): "*Do onsets ever branch?*". Section 6 provides evidence that there exists a phonological rule ("element deassociation") that targets the head in obstruent-liquid events in Florentine Italian and Leon Spanish; it is concluded therefore that these events are complex onsets. It is interesting to see that Lowenstamm also examines the behavior of stop-liquid events in certain languages (e.g., Perfect Formation in Greek), but focuses on the change in the onset dependent without considering the accessibility of the head (under reduplication). This analysis has led him to the conclusion that, in languages like Greek, the obstruent-liquid events are complex segments (with the liquid as a secondary articulation on the obstruent) and to the proposal that all onset complex events are complex segments universally.

Note, finally, that restricting the class of possible structures to complex segments would entail that there is no phonological rule only targeting the head of a complex event. But these rules do exist in certain languages, as this paper has shown.

More generally, we can say that the set of possible structures is related to the set of rules that operate on those structures. Reducing the former also reduces the latter. The moral is: to decide on structures, consider phonological rules.

Thus, both static and dynamic criteria need to be taken into account.

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