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A Theory of Consonantal Interaction*

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Abstract
Co-occurrence restrictions on word-initial consonant clusters are traditionally viewed as a consequence of the relative sonority of both members of the CC. In the first part of this paper, I aim to show that the reasoning underlying this approach is circular. The *observation* that sonority does increase in word-initial clusters is relabelled *explanation* in saying that sonority **must** increase. Since the crucial part of this circular argumentation is expressed by a constraint ("sonority must increase within word-initial clusters"), I address the more general issue of constraints in linguistic theory.

In the second part of the paper, I propose a constraint-free theory where restrictions on word-initial clusters follow from the interaction of more general principles. The main principles I draw on are Government-Licensing (Charette, 1990), segmental complexity (Harris, 1990) and a strict CVCV syllable-structure (Lowenstamm, 1996). None of these devices makes special reference to word-initial clusters. Since word-initial restrictions crucially depend on idiosyncratic properties of the consonants involved, I also investigate the internal structure of consonants. In the representations I introduce, the set of observations commonly subsumed under the label sonority is assigned no phonological status. Rather, it is shown to be a function of known phonological primitives. Finally, a theory of consonantal interaction built on the consonantal identities developed and the principles mentioned is presented. This theory cannot possibly deal with the reverse phenomenology, predicting that word-initial RT-clusters (where 'T' = obstruent, 'R' = sonorant) are impossible in languages of the Indo-European (IE) type.

In §1, the traditional way of handling word-initial clusters is examined. §2 investigates the theoretical status of constraints. The way to proceed in order to build a constraint-free theory is outlined in §3 and §4. In §5, consonantal identities with in-built sonority are developed. §6 is concerned with the paradigmatic/segmental aspect of word-initial restrictions on clusters. The relevant technical devices used are discussed in §7, that is the phonological ECP and the CVCV-model. Finally, §8 addresses the syntagmatic aspect of the restrictions under focus.

1. Word-initial Consonant Clusters and Circularity

If a language exhibits word-initial consonant clusters, either there are no restrictions on the possible combinations (like in certain Afro-Asiatic languages), or only #TR-clusters exist (like in IE languages). There is no language where only RT-clusters occur word-initially. The usual way of accounting for the exclusion of #RT clusters might be summarized as follows:[1] 1) Words cannot begin with a Coda. Thus, the context "word-initial" corresponds to "Onset" on the

syllabic level. 2) In languages of the IE type, consonant clusters are not free word-initially, but both …TR… and …RT… occur word-internally. This distribution matches that of syllabic constituents: "only Onsets in #__" vs. "both Onsets and Codas word-internally". Thus, syllabic structure is responsible for the observed restrictions. 3) The sonority value for each segment can be established independently. Word-initially, i.e. within a branching Onset, sonority must increase. 4) #RT clusters do not exist because their sonority is falling. Hence, they cannot hold within a branching Onset. They cannot be interpreted as a Coda-Onset sequence either because there are no word-initial Codas. Moreover, in typical syllabification algorithms of the Kahnian kind that rely on the maximal cluster-approach, the set of existing #CCs defines the very set of possible branching Onsets for the whole language: "a possible branching Onset are all and only the CCs found in the context # __" (cf. Kahn, 1976; Lowenstamm, 1981).

This approach is circular: It puts the word *because* between two **observations**.

(1) a. observation: "sonority always increases within #CCs"
b. syllabic interpretation: "TR = branching Onset"
c. explanation: "there are no #RT clusters because sonority must increase within branching Onsets"

Circularity is introduced by the word "must": the **only** thing the statement "sonority must increase" follows from is precisely the **observation** "sonority does increase". Thus, the whole approach simply says "X is like it is because it is like it is."

This kind of reasoning is not satisfactory. The problem of "why do RT-clusters not occur word-initially in some languages" still begs the question. Before turning to a different approach based on more general principles, I should like to discuss the concept of *constraint*s that is crucially involved in the circularity of the reasoning.

2. Constraints are observations, not explanations

As has been illustrated above, circularity is induced by the word "must". Constraints crucially rely on this word, which turns an observation into an obligation. Consider the prototypical example in (2).

(2) a.	observation	trees grow straight up
b.	the observed facts are not random	trees always grow straight up
c.	they **must** be as they are	there is a constraint: GR.UP "trees **must** grow straight up"
d.	WHY do we observe these facts? Because there is a constraint.	trees grow straight up because GR.UP forces them to do so

Circularity is an intrinsic property of constraints. The observed facts are never viewed as the consequence of something independent of the observa-

tion such as a more general principle. Uttering the “must” merely says “the observed facts are as they are because I observe that they are as they are”. Actually, the "must" suggesting an explanation is inherent in the word *constraint*. Instead of observing "X is like that", using the word *constraint* in order to refer to an observation suggests that "X is like that, and it cannot be in another way since it must be like that". If X is constrained, something or somebody must be at the origin of its constrainedness. However, the quest for this origin is never undertaken.

Still more oddly, constraints inhibit further investigation. Since the answer to the question WHY? is the constraint, there is no more need to look for an explanation of the facts. In the case of the tree-example, no one will have the idea of connecting the observations to a conditioning factor such as sunlight because the constraint has already explained why trees grow straight up. Or let us take the example of the peach falling down. If physicists had considered that the peach does not go up or zigzag around because there is a constraint saying that peaches must fall down, no relation would ever have been established between falling peaches, their mass and the mass of the earth. In the same way, the moon would be said to turn around the earth because of a constraint that prevents it from drifting away. No relation between the peach, the moon and something like gravitation would ever have been proposed.
Finally, one major goal of theories is to predict what cannot possibly exist. For example, once physicists have observed the behaviour of falling peaches, the phenomenon *gravitation* extends to anything that has a mass. Namely, the prediction is made to the effect that there is no possible world where masses repel each other. Nor is it possible for masses to remain without effect on each other. Thus, the successive pieces of evidence adduced by Isaac Newton (masses attract each other), Yuri Gagarin (but not in space) and Neil Armstrong (they do on the moon, but not so much) showed different manifestations of the universally true principle “masses attract each other”. There was no way for physicists to elude a unified account by positing three different constraints (1. On earth, masses attract each other strongly, 2. On the moon, attraction is poor, 3. In space, there is no attraction) or three different rankings thereof. Anyone can imagine the state of our understanding of physics if they had done so.

Returning to initial consonant clusters, no prediction of any kind is made by the constraint “sonority must increase within a branching Onset”. If a planet were discovered where the reverse phenomenology was found, nothing prohibits to explain the new data by a constraint “sonority must decrease within branching Onsets”. A theory that can cope with all possible data and their reverse is not a theory at all, but a notational artefact enumerating observations. The interpretation of the restrictions on word-initial clusters I develop in the remaining sections cannot possibly do with the existence of such a planet.

3. Questions

If word-initial restrictions on consonant clusters are viewed as a consequence of the constraint "sonority must increase within a branching Onset", the problem has found an answer. No further questions arise.

The questions I should like to ask are:

(3) a. What is sonority? Has some supreme being decided that [r] is a sonorant, but not [t]?
b. What makes something a Liquid? For all other major classes, articulatory criteria such as "obstructs the airflow more or less" can be appealed to.

These questions are worth asking because what is generally referred to as "sonority" is a mere set of **observations**. The only available definition for sonorants is "this segment is a sonorant because it behaves in a special way". The special behaviour opposing the subset of segments called sonorants to the subset called non-sonorants is crosslinguistically stable. It can be observed when looking at the distribution of segments ("only sonorants as the second member of word-initial clusters", "only (preferably) sonorants in Codas", "the more distant a segment is from the Nucleus, the less sonorant it is: C-Son-V-Son-C") or their relative "vocalicity" (e.g. in typical final devoicing systems such as German or Czech, Obstruents devoice domain-finally, whereas sonorants and vowels do not). By these means, a so-called sonority hierarchy can be established where segments are ordered according to their behavioural kinship with vowels.

The sonority hierarchy is a crosslinguistically stable generalization that is based on observations of different kinds. It encodes the obvious existence of a vocalic continuum: segments are not either vocalic or non-vocalic, they are more or less vocalic.

As such, the notion of sonority describes a fundamental observation. Hence, phonological theory is called to account for this non-arbitrary, crosslinguistically stable situation. One thing is self-evident and uncontroversial: sonority is an idiosyncratic property of each segment. Thus, it must be encoded in what defines the identity of each segment, i.e. its internal structure. And indeed, this is what models of consonantal representation generally do: the sonority-value of a given segment is commonly defined by a special primitive (features such as [son], [vocoid] or [approximant] in Feature Geometry, e.g. McCarthy, 1988, the notion of Charm in Government Phonology, cf. Kaye *et al.* (henceforth KLV), 1990).

If it is correct, however, to encode sonority in the internal structure of each segment, using an extra-prime such as, say, [± son] is undesirable. Doing so is nothing more than saying "according to my observations, this object is a sonorant. It thus bears [+ son]." And, in turn, "this object is a sonorant because it bears [+ son]." Again, the whole reasoning is circular.

Sonority should therefore be expressed as a function of the phonological primitives that define each segment. Hence, a non-circular definition of sonority is to be arrived at on the basis of consonantal structures that have been established on sonority-independent grounds. Proposals such as Rice (1992) and Ritter (1997) take their origin in this kind of consideration. I will follow this line when discussing the phonological identity of sonority below. In short, sonority should fall out naturally from an adequate model of consonantal representation. It should be a secondary property of the internal structures proposed.

4. Two Different Kinds of Restrictions

Before turning to consonantal identities, I would like to discuss the correct observation "word-initial restrictions on consonant clusters are related to sonority" in some more detail. As a matter of fact, impossible word-initial clusters belong to two different types:

(4) a. SYNTAGMATIC restrictions
#CCs that do or do not occur depending on the syntagmatic order of their members: #TR is ok, but #RT out. In clusters of this type, the consonants always contrast in sonority.

b. SEGMENTAL/PARADIGMATIC restrictions
There are also CCs of non-contrasting sonority that do not occur word-initially: e.g. *#lr, rl, nl, ln, tp. In these cases, the syntagmatic order of the members is indifferent: they are unattested in any order.

The property "consonant cluster of contrasting sonority" seems to be related to syntagmatic restrictions, whereas the non-occurrence of #CCs of non-contrasting sonority has nothing to do with syntagmatic ordering. Rather, it is the consequence of the cohabitation of two equally sonorant consonants. An explanation for the former is to be sought in lateral relations holding among segments, while the latter must be due to the genuine identity of the consonants involved. In the next section, I will therefore address the question of consonantal representations.

5. Internal structure of consonants

The phonological identity of consonants is a classical issue under debate. Various theories have put forward very different and partly incompatible models for the representation of consonants. Representations diverge as to the phonological primitives they use. Feature Geometry (e.g. Clements 1993; Sagey 1986) assumes multi-valued features whereas Particle Phonology (Schane 1984), Dependency Phonology (Anderson & Ewen 1987) as well as Government Phonology (KLV 1985) rely on bigger, monovalent objects. They contrast with respect to the relations that are supposed to hold between these primitives, i.e. arborescence (Feature Geometry) vs. a dependency-type of relation (the other models

mentioned). But even within a given framework, the various proposals are far from being consensual.

The model of consonantal representation that I shall discuss in more detail below is couched within the framework of Government Phonology. Even though this implies certain assumptions on the type and organization of the phonological primitives used, I will try to present argumentation in a theory-neutral manner. The present paper does not primarily aim at contributing to the debate on particular consonantal representations that is going on within and among models. Rather, the properties I evidence for different consonants should be general enough to be transposable to other frameworks. This kind of approach is necessary because the consonantal identities derived are only the first step of the demonstration intended. In a second step, I shall capitalize on the sonority-oppositions then expressed by the sole means of known phonological primitives in order to account for the restrictions on word-initial clusters.

In the following section, I start by presenting the basic assumptions of the model to be introduced.

5.1 Specific Assumptions on Consonantal Representations

Place limitations do not allow a detailed discussion of the model of consonantal representation introduced below (see Scheer 1996, 1998c for a more developed presentation). I only adduce evidence for properties of the model that differ from other proposals. Special reference will be made to different proposals put forward within Government Phonology including Harris (1990; 1994), Harris & Lindsey (1995), Cyran (1994), Weijer (1994), Rennison (1990; in press).

1.The phonological primitives used, so-called Elements (see KLV 1985; de Carvalho 1997 for discussion), are monovalent objects that are more complex than a single distinctive feature. The vector of palatality for example, **I**, is defined as a high, front, unrounded, non-ATR articulation and as such pronounceable in isolation (cf. Harris 1996): **I**=[I].

2.As illustrated by the equation **I**=[I], there is a one-to-one correspondence between phonetic manifestations and phonological representations: for a given phonological structure, there is exactly one phonetic spell-out, and vice versa. Thus, the acoustic signal of any language gives direct access to phonological structure, and a given phonological representation has a crosslinguistically stable pronunciation. In short, the observable objects and their postulated internal structure contract the same relationship in phonology as, say, in chemistry: water is H_2O on any continent. If it was not, it would not be water anymore. And in turn, H_2O cannot appear as something else than water. The one-to-one relationship between phonetics and phonology is necessary to constrain the grammar and to guarantee the possibility of crosslinguistic argumentation. If [e] were **X**,**Y** in language A and **Z**,**W** in language B, there would be no way to use evidence from the former in order to shed light on the functioning of the latter.

Finally, a system that maximally restricts the phonetic interpretation of phonological structure makes the most precise predictions: a given phonological identity is predicted to sound alike in any language. Hence, a prediction of this kind can potentially be falsified by any language. This situation is desirable because theories are requested to be maximally easily falsifiable in the Popperian sense. The bijective relation of phonetics and phonology is explicitly postulated by, among others, KLV (1990:194), Clements (1993:101), Harris (1996) and Harris & Lindsey (1990;1995:46ff). Under this assumption, the classically assumed phonetic component of the grammar has no place: "purely phonetic effects" do not exist in this view.

3.The contribution of primitives within a given segment is asymmetrical. Like in any other linguistic domain, the head determines the phonetic output of the complex expression to a greater degree than its dependents. In the representations developed below, the head Element is underscored. Primitives that are not the head of the expression are dependents/operators. In an **I**-headed expression, e.g. where **A** is operator, **I** transmits more of its properties to the output than **A**, the result being the front mid vowel [E]=**I**–**A**. In the reverse situation, the result is closer to **A** than to **I**, that is **A**–**I** corresponds to the front low vowel [æ].

4.Vowels only use a subset of the places of articulation that can be found in consonants: consonants and vowels can be palatal or velar, but only consonants may be uvular, labio-dental or glottal. By contrast, consonants and vowels do not seem to share common features as to the manner of articulation: only consonants are obstruents or Liquids. As a consequence, exchanges of Place-defining primitives between vocalic and non-vocalic positions are very frequent. In the case of palatalizations for instance, there must be a single primitive responsible for palatality in the triggering vowel and in the palatalized consonant: same causes, same effects. If palatality were carried by a specifically vocalic primitive unknown in consonants, it could never spread to non-vocalic positions. Place-assimilation phenomena between vowels and consonants have led to the nowadays received requirement that the set of primitives that define the Place of articulation be identical for consonants and vowels (see e.g. Clements 1993; Smith 1988; Carvalho & Klein 1996; Weijer 1994:25,28; Cyran 1994:7; Harris & Lindsey 1995:65f). For consonantal representations that have been proposed within Government Phonology (e.g. Harris 1990; 1994), this means that the Element **R** representing coronality has to be abandoned, as it does not occur in vowels (for more detailed evidence against **R**, see Broadbent 1991; Backley 1993; Brockhaus 1994).

5.2 Inventory of Primitives

The inventory in (5) shows the primitives I assume to intervene in the definition of vocalic as well as consonantal segments. The glosses indicate the articulatory information carried by each prime.

(5) a. *Place Elements* — *phonetic result*

I	palatality	[ɪ]
U	velarity	[ɯ]
B	labiality/roundness	[ʉ]
A	aperture, RTR[2]	[a]
v	unmarkedness, relaxed tongue body position	[ɨ]

b. *Manner Elements*

?	constriction
h	noise
B	labiality/roundness
N	nasality
ɬ	ATR[3]
L	lax vocal cords
H	stiff vocal cords
T	Trill

Most of the primitives shown are commonly used in the models quoted above. Only **B** and **T** need to be introduced more carefully. The next section addresses issues related to these two primes.

5.3 Velarity and Roundness Are Two Distinct Phonological Objects

Representational models like KLV (1985) or Anderson & Ewen (1987) define the primitive **U**/|u| as the representative of high back tongue body position. Nevertheless, its salient property is claimed to be roundness. This entails the prediction that **U**/|u| is absent from any non-rounded articulation.

The proposal merging velarity and roundness is the consequence of a crosslinguistic observation: in most languages, any back vowel is rounded, whereas no language exists where any front vowel would be automatically rounded.

The prediction that **U** is absent from any unrounded articulation faces a number of problems, however, among which the existence of back unrounded vowels [ɯ,ɤ,ʌ] and the fact that all velar consonants [k,g,x,ɣ] are unrounded (see Roca 1994:120 on this point). Claiming that the primitive that defines the back = velar Place of articulation, i.e. **U**, does not contribute to the articulation of consonants (and some vowels) that share the same Place of articulation seems odd in itself.[4] Rather, data from various languages given in (6) show that [u,w] that uncontroversially contain **U** do interact with velar consonants.

(6) *Interactions of* [u,w] *with velar consonants*

a. In Fular,[5] [w] regularly alternates with [g] (Klingenheben 1941:65; 1927:111ff explicitly on this point). Consider for example the different forms of the stem *wor* ‘masculine’ when connected to the various adjectival nominal class-suffixes.

class		*class*		*class*	
1	ᵑgor-ba	9	gor-gal	18	ᵑgor-koj
2	wor-de	10	gor-gel	20	wor-ʔbe
3	ᵑgor-di	11	gor-gol	21	gor-ʔde
4	wor-du	13	gor-ki	22	gor-ʔdi
5	ᵑgor-ga	15	ᵑgor-ko	23	gor-ko
8	ᵑgor-gu				

b. *Broken plural formation in Moroccan Arabic.*
In the variety of Moroccan Arabic described by Ettajani (in prep.), only velar and uvular consonants tolerate a labial secondary articulation: [k^w,χ^w,q^w] exist, whereas *[s^w,D^w] etc. do not occur. This distribution is transparent in broken plural formation where a [w] tries to parachute onto the first root-consonant (data and analysis by Ettajani):

1. Labial secondary articulation possible:

sing.	*broken plural*	
kbir	k^wbar	‘tall’
χubza	χ^wbazi	‘bread’
χurza	χ^wrazi	‘node’
kursi	k^wrasi	‘chair’
qamiʒa	q^wamiʒ	‘shirt’

2. Labial secondary articulation impossible:

sing.	*broken plural*		
smin	sman	*s^wman	‘fat’
siɬla	slali	*s^wlali	‘basket’
Drif	Draf	*D^wraf	‘nice’

c. *Short* [u] *in Ge'ez (Classical Ethiopian):*
In Ge'ez (Ségéral 1995:155ff), short high peripheral vowels do not exist. Only a short [u] can be observed in nominal morphology iff it is preceded or followed by a velar or uvular consonant [k,g,q,x].

d. *Czech vocative*
In Czech, three vocative allomorphs occur with consonant-final masculine nouns: *-i* iff the last consonant of the stem is palatal, *-u* iff it is velar, and *-e* elsewhere.

	nominative	*vocative*	
-i / C_{pal}__	kuuɲ	kɔɲ-i	‘horse’
	tɔmaaʃ	tɔmaaʃ-i	‘Thomas’
	ɬɦaař	ɬɦaař-i	‘liar’
	złɔɟɛj	złɔɟɛj-i	‘thief’
	słɛc	słɛɟ-i	‘herring’
-u / C_{vel}__	ɦɔx	ɦɔx-u	‘boy’
	zdɛɲɛk	zdɛɲk-u	first name
	ptaak	ptaak-u	‘bird’

-e / elsewhere	pɛs	ps-ɛ	‘dog’
	dɔktɔr	dɔktɔr-ɛ	‘doctor’
	ɦɔɬup	ɦɔɬub-ɛ	‘pigeon’
	ɦirat	ɦirad-ɛ	‘castle’
	ʃɛf	ʃv-ɛ	‘seam’

The interaction of [u,w] with labials on the other hand is well established and encoded in any of the representational models quoted. Thus, consonantal representations should reflect the affinity of [u,w] with both labials and velars/uvulars. In systems where velarity and roundness are undissociable, the velarity-primitive cannot be linked to velar consonants because [k,g,x,ɣ] would then be predicted to surface as rounded articulations. I therefore propose two different primitives for velarity and roundness:

(7) a. **U** — velarity
b. **B** — roundness/labiality

This idea is not original, cf. Lass (1984:278f),[6] Rennison (1990:187).[7] Under these provisos, labio-velar articulations such as [u,w] have the phonological identity **U**–**B**. Their interaction with labial consonants is due to the labial agent **B**, their relation with velars/uvulars involves the velar primitive **U**. **B** is present in all labial, **U** in all velar/uvular consonants.

Proposing two independent vectors for velarity and roundness/labiality has consequences for the representation of vowels in an Element-based system. Namely, front rounded vowels are not a combination of **I** and **U**, but of **I** and **B**. Relevant vocalic structures with **U** and **B** are given in (8).

(8)

I	I	I	I	v	v	v	v	U	U	U	U	U	I		*I/U-line*
	A	|	A		A	|	A		A	|	A	A	A	A	*A-line*
		B	B			B	B			B	B				

i	e	y	ø	ɨ	ə	ʉ	ɵ	ɯ	ɤ	u	o	ɑ	æ	a
ɪ	ɛ	ʏ	œ					ъ	ʌ	ʊ	ɔ			
j		ɥ						ɯ̯		w				

Phonological primitives are supposed to reside on autosegmental lines. The number of lines is parametrically variable depending on the combination of Elements (KLV 1985). Elements sharing a given line cannot combine. Thus, in a language like Arabic with only three vowels i,a,u where no elemental combinations occur, all three Elements reside on the same line. In a five-vowel system where mid vowels illustrate combinations of **A** and **I**/**U**, two lines are supposed, one carrying **A**, the other shared by **I** and **U**. Finally, in systems with front rounded vowels, every Element is said to reside on a line on its own because **I** and **U** combine. One consequence of the dissociation of roundness and velarity

is that there is no combination of **I** and **U** in any circumstance: front rounded vowels are expressed as a combination of **I** and **B** rather than of **I** and **U**. Hence, maximally two melodic lines group **A**, **I** and **U**, as shown in the above diagram. The non-occurrence of combinations of **I** and **U** is a desirable effect. In models where both primes are allowed to combine in vowels, they are expected to be able to do so in consonants as well. However, in all models quoted, **I** and **U** do never co-define a consonant. The issue of varying behaviour of **I** and **U** in consonants and vowels does not arise when (8) is assumed.

Let us now turn to the status of the labial primitive. **B** was introduced as the vector of roundness and labiality. This hybrid status is simply the translation of the fact that it contributes roundness to vocalic articulations, whereas it is responsible for the labiality of labial consonants. Two different terms are requested because both objects stand in an intimate relation, without being identical: any rounded articulation is labial, the reverse being wrong.

5.4 Only Place Definers Are Heads

Consonants can be grouped according to several Manners of articulation that do not occur in the vocalic domain (stops, fricatives, voiced, unvoiced). Possibly, each of the manners of articulation is to be represented by a special primitive. Postulating a prime for each Manner of articulation leads to overgeneration, a classical problem of systems of consonantal representation. I propose to approach this issue by limiting the possible heads to Place-definers. Under these provisos, only the "melodic" Elements **v**, **I**, **U**, **A**, **B** can dominate segmental expressions. This way of viewing phonological structures has an articulatory foundation: if some segments were said to be headed by a Manner-definer, say, **ʔ**, whereas others are not, the prediction would be that these articulations have higher stopness than the ones where **ʔ** is an operator. In Harris's (1990) model, for example, bilabial stops are headed by **ʔ**, whereas all other stops are dominated by an Element other than **ʔ**. According to the dependency-principle that heads contribute more of their properties to the phonetic output than operators, [p,b] should be more occlusive than, say, [t,d], a prediction that is not supported by either articulatory, phonetic or phonological evidence.

The idea of restricting heads to Place-definers is not new. It implicitly controls the vocalic representations proposed by KLV (1985): out of the six primitives of the model (**v**,**I**,**U**,**A**,**Ɨ**,**N**), only the Place definers **v**, **I**, **U**, and **A** head segmental expressions. **N**- or **Ɨ**-headed structures complemented by another Element do not occur.

The same idea is also present in the representations proposed within Feature Geometry (e.g. Clements 1993) where Place and Manner definers are grouped under categorically different and hierarchically distant nodes, and Dependency Phonology (e.g. Anderson & Ewen 1987) where primitives depending on a Manner-gesture never dominate segmental expressions.

As mentioned in the preceding section, **B** is by nature a hybrid primitive carrying Place as well as Manner information. In the representations to be developed, **B** will be able to head an expression iff it contributes to the Place-definition of the articulation (labial consonants). On the other hand, **B** will never dominate phonological expressions when contributing to the Manner of articulation (as in rounded vowels and [ʃ,ʒ], the only rounded consonants).

5.5 [t,d] Are Nothing

Another feature of the consonantal representations advocated here needs further discussion. That is, [t,d] are articulated without contribution of any of the melodic primitives **I**, **U**, **A**, **B** (see Szigetvári 1994 for an identical proposal). Two kinds of arguments support this claim: markedness considerations and the epenthetic status of [t,d].

Firstly, [t,d] seem to be present in almost all languages (cf. Nartey 1979; Maddieson 1984). No other consonant has a similar status. Second, [t,d] seem to be unmarked within the class of coronals that, as a whole, are unmarked with respect to other Places of articulation (see the discussion in Paradis & Prunet 1991). Namely the fricative coronals [s,z] sharply contrast with [t,d] as far as their phonological behaviour is concerned (see e.g. Szigetvári 1994:198). This situation has led to a view of [t,d] as placeless articulations in underspecification approaches (see e.g. Archangeli 1988). In the vocalic domain, maximal unmarkedness is typically viewed as a consequence of the absence of Place-definers. KLV (1985) for example attribute the empty set represented by **v** to [ɨ], which is said to be the surface manifestation of empty Nuclei. Following the same argumentation, [t,d] are melodically empty, i.e. the phonetic manifestation of an empty Onset. Moreover, KLV (1985) argue for the unmarkedness of [ɨ] on articulatory grounds: [ɨ] corresponds to the position of the tongue body in relaxation. In the same way, [t,d] can be said to represent the consonants that are produced with the position that the tongue body occupies when no articulatory activity is carried out. The apex has just to be raised to the alveolus (contribution of **ʔ**, **h**).

Accordingly, the internal structure of [t,d] is **v**–**ʔ**–**h**.

Second, let us consider the status of [t,d] as epenthetic consonants. In French, hiatuses that arise in certain morphological environments are regularly broken up by [t]:

(9) /a il dit/ --> a-**t**-il dit ‘he has said’
/verra on/ --> verra-**t**-on ‘we will see’

The same phenomenon occurs between two morphemes belonging to the same word:

(10) a. *Epenthetic* [t]

/esquimau + age/	-->	esquimau**t**age
/glouglou + er/	-->	glouglou**t**er
/bijou + ier/	-->	bijou**t**ier
/indigo + ier/	-->	indigo**t**ier
/tableau + in/	-->	tableau**t**in
/cacao + ière/	-->	cacao**t**ière

b. *Epenthetic* [d]

/Marivaux + er/	-->	marivau**d**er

From Middle High German to New High German,[8] [t,d] develop at morpheme boundaries after [n,r,s,x,g,f] (a phenomenon called *Sproßkonsonant* or *Dentalwuchs*, cf. Paul *et al.* 1989:161).

(11)

	MGH	NHG	
a.	*After* [n]		
	iergen	irgen**d**	'any'
	ieman	jeman**d**	'somebody'
	wîlen	weilan**d**	'long ago'
	vollen	vollen**d**s	'completely'
	totzen	Dutzen**d**	'dozen'
	sinvluot	Sin**t**flut	'Flood'
	allenhalben	allen**t**halben	'everywhere'
	wësenlîch	wesen**t**lich	'important'
b.	*After* [r]		
	anderhalp	ander**t**halp	'one and a half'
	saf	Saf**t**	'juice'
c.	*After* [s]		
	ackes	Ax**t**	'axe'
	obeʒ	Obs**t**	'fruit'
	sus	sons**t**	'otherwise'
	bâbes	Paps**t**	'pope'
d.	*After* /x/		
	habech	Habich**t**	'hawk'
	dornach	Dornach**t**	city
e.	*After* [g] (rare)		
	bredige	Predig**t**	'sermon'
f.	*After* [f]		
	werf	Werf**t**	'shipyard'

The status of [t,d] as privileged epenthetic consonants is compatible with a minimal phonological substance. If the expressive power of the grammar is constrained by an Extended Projection Principle (see KLV 1990:221 for the

initial proposal) as in (12), then possible epentheses are limited to segments without melodic content.

(12) Observable objects on the surface have a lexical origin or are the result of a derivation based on lexically present material. “Nothing falls from heaven”.

Finally, it is intriguing to observe that [t,d] are very often and very easily affected by phonological processes, but almost never constitute their output. Under the assumption that [t,d] lack any melodic content, this observation receives a natural explanation: if phonological processes move or replace primitives, the adjunction of a primitive to a given structure cannot possibly yield an empty object. And of course nothing can be replaced within an object with no content.

*5.6 Distribution of **A** in Obstruents: spirantization*

In this section, I use the evidence provided by spirantization to gain insight into the internal structure of the segments involved in this process. I will first consider the case of a classical spirantization, that is Grimm's Law (or First Consonant Shift), where the stops and fricatives involved contrast with respect to their Place of articulation. In a second step, I will examine Spanish and Tiberian Hebrew spirantizations. In these languages, the Place of articulation of stops and fricatives remains stable.

5.6.1 Spirantizations Accompanied by a Shift in the Place of Articulation

Consider the relevant data illustrating Grimm's Law given below (e.g. Paul *et al.* 1989:113f):

(13) Latin and Greek forms witness the Indo-European state of affairs (Gothic spelling þ=[θ]).

a. *Spirantization*[9]

IE	>Germ.	>Goth.		Lat./Gr.	Goth.	
p,p^h	f	f		pater	fadar	‘father’
	v	b		septem	sibun	‘seven’
b^h	v	b		fero	bairan	‘carry’
t,t^h	θ	θ		tres	*þreis	‘three’
	ð	d		pater	fadar	‘father’
d^h	ð	d	Gr.	δύρα	daur	‘gate’
k,k^h	χ	h		cornu	*haurn	‘horn’
	ʁ	g	Gr.	δάκρυ	*tagr	‘tear’
g^h	ʁ	g		hostis	gasts	‘stranger’

b. *Devoicing*

b	p	p	(s)lubricus	*sliupan	‘sneak’
g	k	k	ego	ik	‘I’
d	t	t	edo	itan	‘eat’

The following three correspondences characterizing Grimm's Law can thus be established for the oldest record of Germanic (see e.g. Collinge 1985:63ff):

(14)	*Indo-European*	*Gothic*
a.	STOP, + voice, – asp	STOP, – voice, – asp
b.	STOP, + voice, + asp	STOP, + voice, – asp
c.	STOP, – voice, ± asp	[FRIC, – voice, STOP, + voice] – asp

In the light of various secondary processes such as the Second Consonant Shift and using arguments of comparative nature, the following correspondences are commonly reconstructed for (unrecorded) Common Germanic (see Collinge 1985; Paul *et al.* 1989 for further discussion):

(15)	*Indo-European*	*Germanic*
a.	STOP, + voice, – asp	STOP, – voice, – asp
b.	STOP, + voice, + asp	FRIC, ± voice
c.	STOP, – voice, ± asp	[FRIC, – voice]

According to classical interpretation (e.g. Paul *et al.* 1989:113), the chronology of events is as follows: in a first step, IE non-aspirated unvoiced stops develop aspiration: IE p,t,k > Germ p^h,t^h,k^h. Then, all aspirated stops, voiced or not, become fricatives: IE p^h,b^h, t^h,d^h, k^h,g^h > Germ f/v, θ/ð, χ/ʁ.[10] The IE non-aspirated stops that are left remain non-aspirated AND stops, but they devoice: IE b,d,g > Germ p,t,k.

The table in (16) summarizes the evolution discussed.

(16)

	non-aspirated		*aspirated*	
	voiced	*unvoiced*	*unvoiced*	*voiced*
inventory of IE stops	b, d, g	p, t, k	p^h, t^h, k^h	b^h, d^h, g^h
Germanic			p^h, t^h, k^h	b^h, d^h, g^h
Grimm's Law	p, t, k		f/v, θ/ð, χ/ʁ	

The crucial features of Grimm's Law to be emphasized are 1) only aspirated stops spirantize, and 2) the Place of articulation of the stops is **always** different from the one of the resulting fricatives (bilabial > labio-dental, alveolar > interdental, velar > uvular).

As only aspirated stops spirantize in these languages, it seems adequate to regard aspiration as a trigger of spirantization.

5.6.2 Spirantizations with no shift in the Place of articulation

In contrast with the example of spirantization discussed in the previous section, there is another kind of spirantization where the Place of articulation of the stops and the resulting fricatives remains stable. Consider the Spanish case below, where only voiced stops undergo the spirantization triggered by a preceding vowel (data from Hooper 1976:208ff; Hyman 1975:62):

(17) a. *Fricatives occur after vowels:*

la **β**aŋka	*la banca*	‘the bank’
la **ð**emora	*la demora*	‘the delay’
la **ɣ**ana	*la gana*	‘the desire’

b. *Stops occur elsewhere:*

1. *word-initially*

baŋka	*banca*	‘bank’
demora	*demora*	‘delay’
gana	*gana*	‘desire’

2. *after consonants*

am**b**os	*ambos*	‘both’
on**d**a	*onda*	‘wave’
al**d**ea	*aldea*	‘village’
teŋ**g**o	*tengo*	‘I have’

The alternations involved are [b ~ β], [d ~ ð] and [g ~ ɣ]. Apart from [d ~ ð] (on this point, see Scheer, 1996:229ff), the place of articulation is invariable: bilabial–bilabial, velar–velar. The phenomenon observed in Spanish also contrasts with the spirantizations discussed earlier in that the triggering context has nothing to do with aspiration but makes reference to sonority: fricatives surface in postvocalic contexts.

A similar situation obtains in Tiberian Hebrew where any stop, voiced or not, undergoes spirantization in postvocalic contexts (data from Elmedlaoui 1993:124):

(18)

	perfective	*imperfective*	*alternation(s)*	
√zkr	zaa**x**ar	yi-z**k**or	x ~ k	‘remember’
√kpr	kaa**ɸ**ar	yi-**xp**or	k ~ x, ɸ ~ p	‘cover’
√bdl	**b**aa**ð**al	yi-**βd**al	b ~ β, ð ~ d	‘separate’
√pth	**p**aa**θ**ah	yi-**ɸt**ah	p ~ ɸ, θ ~ t	‘open’
√pgf	**p**aa**ɣ**af	yi-**ɸg**of	p ~ ɸ, ɣ ~ g	‘meet’

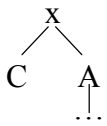
Like in Spanish, the Place of articulation remains stable (except for the dentals), and the triggering context is defined in terms of sonority (fricatives appear iff the alternation-site is preceded by a vowel).

5.6.3 Summary

For the languages considered, the couples [triggering aspiration — shift in the Place of articulation] and [triggering sonority — no shift in the Place of articulation] are in complementary distribution. If segments of higher sonority assimilate nonsonorant stops to more sonorant fricatives, the Place of articulation remains the same. If on the other hand aspiration causes the spirantization of stops, a change in the Place of articulation ensues.

Hence, we have to address the question regarding the causal relation between aspiration and the instability of the Place of articulation. It is uncontroversial that aspiration is a secondary articulation involving a fricative glottal activity. The phonological primitive commonly related to glottal activity is the one responsible for aperture, that is **A** (=RTR Retracted Tongue Root), [low], etc. (e.g. Harris 1994:119; Clements 1993; Angoujard 1992). Accordingly, **A** is likely to be involved in the secondary articulation at hand.[11]

(19)



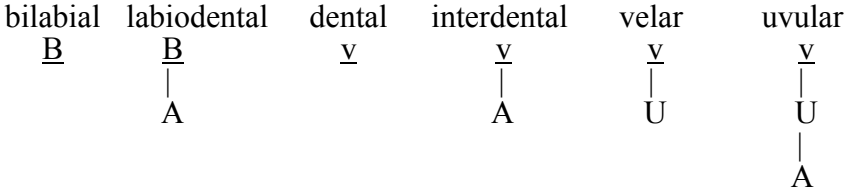
[C^h]

A will therefore be regarded as the melodic Element involved in the two changes observed in Grimm-style spirantization (i.e. spirantization and Place-modification). Since **A** is a Place-definer, it is natural to assume its implication in related processes. If **A** is the melodic primitive responsible for the changes in the Place of articulation of the stops, the following correspondences obtain:

(20) a. bilabial + **A** = labio-dental
b. dental + **A** = interdental
c. velar + **A** = uvular

Hence, knowing about the phonological identity of bilabial (=**B**, see above), dental (=**v**) and velar (**v**–**U**, according to the above discussion and the KLV-idea that velars are **v**-headed, see e.g. Harris 1990; 1994) stops, the phonological identity of labio-dental, interdental and uvular fricatives may be calculated.

(21)



If **A** is responsible for the Place-modification, the question as to why the stops at hand spirantize remains. In order to approach this issue, let us consider what kind of articulation would obtain if there were no spirantization. The incorporation of **A** into the stops would yield labio-dental, interdental and uvular stops, respectively. Labio-dental and interdental stops do not exist (or are extremely marked, in any case non-phonemic). This situation raises the more general question why some Places of articulation lack stops (whereas there is no Place for which only stops exist to the exclusion of fricatives): labio-dental (corresponding to [f,v]), interdental (corresponding to [θ,ð]), alveo-palatal (corresponding to [ʃ,ʒ]) or pharyngeal (corresponding to [ħ,ʕ]) stops are unknown.

Why is there for example no stop with the same Place of articulation as [ʃ,ʒ], whereas [x,ɣ] have [k,g] as their stop-equivalents sharing the same Place of articulation.

I propose a single answer to both questions:

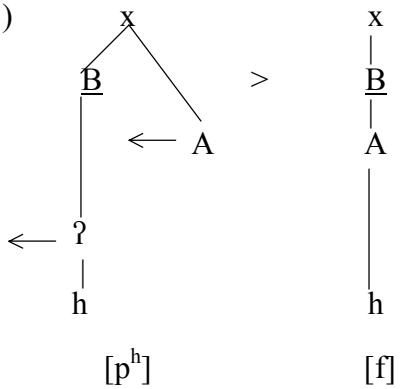
(22) a. Stops incorporating **A** as in Grimm's law spirantize,
b. some Places of articulation lack stops because
A and ʔ are incompatible within a given phonological expression

This statement reflects the fact that both primitives involved, i.e. **A** = aperture and **ʔ** = occlusion, are maximally antipodal both as far as their articulation is concerned, and also with respect to the phonological behaviour of the segments they define. **A** represents minimal, **ʔ** maximal obstruction of the airflow. **A** = [a] is maximally sonorant, whereas stops are the least sonorant segments.

Assuming that **A** and **ʔ** are mutually exclusive has the following advantages:

1) Spirantization is an ordinary assimilation process where less sonorant objects become more sonorant in a sonorant environment (e.g. Spanish). Unless (22) is assumed, there is no apparent reason why the incorporation of **A** into stops should produce fricatives (e.g. Grimm's Law). The Spanish type can be viewed as a true spirantization, whereas the Grimm-type turns out to be a "false spirantization": spirantization here is only a secondary consequence of the fact that **A** and **ʔ** meet within the same segment. **A** changes the Place of articulation. As a consequence of its presence, **ʔ** is expelled from the internal structure of the segment. The following example illustrates [p^h] > [f].

(23)

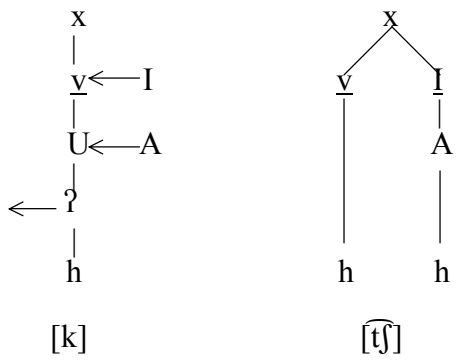


2) The absence of stops for certain Places of articulation is a straightforward consequence of the contribution of **A** to the articulation of the corresponding fricatives ([f,v], [θ,ð], [ʃ,ʒ], [ħ,ʕ]).

3) The most common affricates [p͡f], [t͡s, d͡z], [t͡ʃ,d͡ʒ] match exactly the 'holes' of lacking stops: [p͡f] is the labio-dental stop missing in its simplex form for the reasons stated above, [t͡s, d͡z] are the stops corresponding to [s,z] ([t,d] do not have this function since their fricative versions are [θ,ð], not [s,z], as demonstrated by spirantization), and [t͡ʃ,d͡ʒ] fill the empty stop-slot facing

[ʃ,ʒ]. Affricates illustrate another possible result of what might happen when **A** and **ʔ** are projected onto one another. In the case of Grimm's Law, **ʔ** has been completely expelled. In the case of affricates, **ʔ** is expelled from the phonological expression **A** contributes to. It is nevertheless maintained in a secondary articulation of a contour segment. Consider for example the creation of [t͡ʃ] resulting from the projection of **A** and **I** onto [k]:

(24)



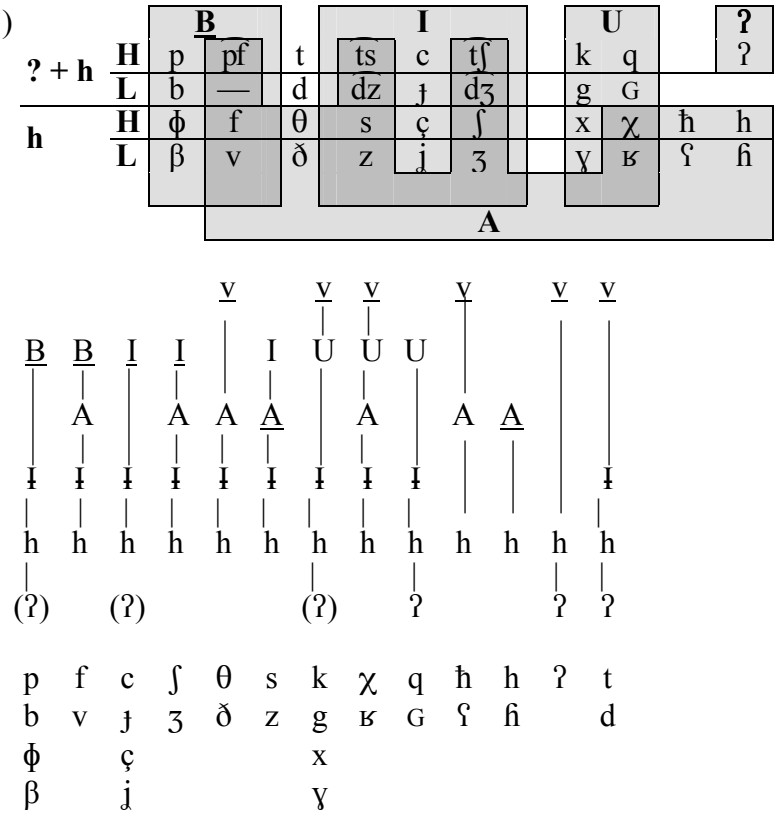
This analysis can contribute to the understanding of the most common pattern of spirantization found in diachrony, that is stop > affricate > fricative. As an example, the evolution of Latin velar stops through affricates to French [ʃ,ʒ] occurring before [a] can be partly accounted for: Latin *gamba*, *carru* > Gallo-Romance d͡ʒãmbə, t͡ʃar > French ʒãb, ʃaχ 'leg, tank'. Even though the source of the palatal agent remains mysterious, the role played by the triggering context "__a" is better understood: "__a" does not cause palatalization; it triggers affrication /spirantization.

5.7 Internal structure of Obstruents

In the preceding sections I examined those properties of the consonantal identities advocated here that diverge from standard assumptions. The remaining representations of Obstruents are more consensual. For instance, the labial primitive **B** is present in all labials, the vector carrying palatality **I** is present in palatals [c,ɟ,ç,j] and alveo-palatals [ʃ,ʒ] (but also, more controversially, in [s,z]), the velar primitive **U** contributes to the articulation of velars and uvulars, and the aperture-primitive **A** is common to gutturals. Moreover, the primitive representing ATRness **Ɨ** is viewed as an activator of the buccal cavity. Thus, it is present in buccal, and absent from non-buccal, i.e. guttural articulations. For example, **Ɨ** distinguishes between the buccal epenthetic consonants [t,d] and the non-buccal epenthetic consonant [ʔ], both being identical as far as their melodic properties are concerned.

The table in (25) summarizes the consonantal identities I propose (for further discussion, see Scheer 1996; 1998c).

(25)



5.8 Liquids and Nasals

*5.8.1 [r] is made of **A** and **I***

The evolution of Germanic languages evidences the tight relation between [r] and low vowels. In (standard) German for instance, the former MHG apical [r] is distributed as follows (see e.g. Drosdowski 1984:35f, 57 for more illustration).

(26)	a.	[r] > [ɐ] / V __ #	fooɐ	*vor*	‘before’
			nuɐ	*nur*	‘only’
			hɔʁɔɐ	*Horror*	‘horror’
			mawɐ	*Mauer*	‘wall’
			bææɐ	*Bär*	‘bear’
			biiɐ	*Bier*	‘beer’
			leeɐ	*leer*	‘empty’
			fɔjɐ	*Feuer*	‘fire’
	b.	[r] > [ɐ] / V __ C	luɐç	*Lurch*	‘amphibian’
			gəbɪɐgə	*Gebirge*	‘mountain’
			lɔɐt	*Lord*	‘Lord’

c.	[r] > [a] / a __ {C,#}	baat	*Bart*	'beard'
		baaʃ	*Barsch*	'perch'
		faat	*Fahrt*	'trip'
		gaa	*gar*	'done, cooked'
d.	[r] > [ʁ/χ] / C __	dʁaj, *dɐaj	*drei*	'three'
		gʁajs, *gɐajs	*Greis*	'old man'
		pχajs, *pɐajs	*Preis*	'price'
e.	[r] > [ʁ] / V __ V	pɪʁaat	*Pirat*	'pirate'
		kaʁaat	*Karat*	'carat'
		ooʁaan	*Oran*	Algerian city

In word-final position after a vowel (other than [a]) (*vo**r***) and after a vowel (other than [a]) followed by a consonant (*Gebi**r**ge*), MHG [r] has become a low vowel different from [a] that Drosdowski (1984:57) transcribes central [ɐ]. In the same context, if the vowel preceding MHG [r] is [a], the result is a long [aa] (*Ba**r**t, ga**r***). Elsewhere, that is intervocalically (*Pi**r**at*) and after a consonant (*d**r**ei, P**r**eis*), the former [r] is realized [χ,ʁ] according to the voice-value of the preceding segment.

As (26) shows, the vocalic variant of [r] seems to be [a] or [ɐ]. I therefore propose that [r] is **A**-headed.

Lowering-activity of [r] is also reported for English where only mid and low vowels occur before etymological [r] (cf. Harris 1994:244). Cyran (1994:210) and Broadbent (1991) adduce more evidence supporting the presence of **A** in [r].

Furthermore, the following evidence suggests that **I** also contributes to the articulation of [r]. In Southern Dutch (Rotterdam, Leiden), [j] can replace [r] word-finally and before a consonant:

(27)	*standard Dutch*	*Southern Dutch*		
	daa**r**	daa**j**	*daar*	'over there'
	kaa**r**t	kaa**j**t	*kaart*	'card'
	stɔɔ**r**t	stɔɔ**j**t	*stoort*	'disturb 2SG.PRES'
	ka**r**nən	ka**j**nən	*karnen*	'make buttermilk'
	vɛ**r**pt	vɛ**j**pt	*werpt*	'throw 3SG.PRES'

In the same context, Caribbean Spanish exhibits [j] where standard Spanish shows [r,l] (data from Harris 1983):

(28)	*standard Spanish*	*Caribbean Spanish*	
	revo**l**ve**r**	revo**j**ve**j**	'revolver'
	ka**r**ta	ka**j**ta	'card'
	pape**l**	pape**j**	'paper'
	a**l**go	a**j**go	'something'

This kind of phenomenon occurring in the typical lenition-context "__C,#" is analysed as a segmental decomposition by Harris (1992). If this way of interpret-

ing the above data is correct, the result of the decomposition [j]=**I** must also be present in the original [r,l].

5.8.2 [r], [l] and [n] Are Variants of the Same Phonological Object

Several genetically non-related languages present alternations of [r], [l] and [n] without apparent segmental conditioning.

In Chaha (Ethio-Semitic language) for instance, [r] and [n] are allophones, [n] occurring word-initially and before obstruents, [r] elsewhere (see Leslau 1950:118 for a more detailed description).

(29)

	PRETERITE	PRESENT	JUSSIVE	√	
1SG	**n**ädäf-x^{w}ɨm	ä-**r**ädɨf	n**ɨ**-**n**dɨf	Rdf	‘card (wool)’
1SG	**n**äk^{y}äm-x^{w}ɨm	ä-**r**äk^{y}ɨm	n**ɨ**-**r**äk**ɨ**m	Rk^{y}m	‘ride (horse)’

In Korean, [l] and [r] are allophones. [r] is found intervocalically, whereas [l] occurs word-finally and in consonantal environments (data from Labrune 1993:336, 342):

(30) √aR ‘know’

/aR + ta/	-->	aa**l**-ta	CITATION FORM
/aR + ʉpnita/	-->	a**r**-ʉpnita	POLITENESS FORM
/aR + ʉo/	-->	a**r**-ʉo	EXHORTATIVE FORM
/aR + a/	-->	a**r**-a	DECLARATIVE FORM

Moreover, [l]/[r] have a third allophonic variant word-initially, that is [n] (but not every Korean [n] is an allophone of [l]/[r]):

(31) √Rak

/o + Rak/	-->	o-**r**ak	‘diversion’
/ø + Rak/	-->	**n**ak	‘pleasure’
/Rak + wɔn/	-->	**n**ak-wɔn	‘paradise’

Like in Chaha, the allophonic relationship between [n], [r] and [l] suggests a unique melodic identity for all three segments.

In MHG, finally, there are numerous doublets of the same word involving [l] and [r] (cf. Paul *et al.* 1989:144).

(32)

[r]	[l]	NHG	
He**r**ke	He**l**che	*Helke*	female first name
smie**r**en	smie**l**en	—	‘smile’
prio**r**	prio**l**	*Prior*	‘prior’
murme**r**n	murme**l**n	*murmeln*	‘murmur’
Cante**r**bury	Cande**l**berc	*Canterbury*	Canterbury
marmo**r**	marme**l**	*Marmor*	‘marble’
marte**r**	marte**l**	*Marter*	‘torture’
mörte**r**	mörte**l**	*Mörtel*	‘mortar’
turte**r**	turte**l**	*Turteltaube*	‘turtledove’
mô**r**ber	mû**l**ber	*Maulbeere*	‘mulberry’

MHA dö**r**pe**r** ‘farmer’ > dö**r**pe**l** > tö**r**pe**l** > NHG Tö**l**pe**l** ‘dolt’
This “confusion” also suggests that [l] and [r] are made of the same phonological substance.

*5.8.3 [l] and [n] contain **I***
In (standard) German, [χ] and [ç] are in complementary distribution. [ç] occurs after front vowels, [χ] after [a,o,u]:

(33)	a.	[χ] *after* [u,o,a]	[ç] *after* [y,ø,i,e]	
		Absence of **I**	*Presence of* **I**	
		buuχ	byyçʁ	‘book SG./PL.’
		kɔχ	kœçɪn	‘cook MASC./FEM.’
		baχ	bɛçə	‘creek SG./PL.’
			ɪç	‘I’
	b.		mɪlç	‘milk’
			mançə	‘some’

As can be seen in (33a), [ç] is the palatalized version of underlying /χ/: in [kɔχ] vs. [kœçɪn] ‘cook MASC./FEM.’, the **I** contained in the feminine suffix umlauts the root-vowel which, in turn, palatalizes /χ/ into [ç]. However, [ç] also occurs after [n] and [l] as shown in (33b). Since the eventual palatality of /χ/ is induced by the preceding segment, these consonants must be **I**-providers.

Italian also evidences the presence of **I** in [l]. As a second member of branching Onsets, [j] is the regular reflex of former [l], as evidenced for example by *più* < *plus*.

5.8.4 Lowering Properties of Nasals
MHG high vowels followed by a (geminated) Nasal regularly surface as mid vowels in NHG (cf. Paul *et al.* 1989:79).

(34)	MHG	NHG	
	sunne	Sonne	‘sun’
	sumer	Sommer	‘summer’
	kumen	kommen	‘come’
	münech	Mönch	‘monk’
	sun	Sohn	‘son’
	künec	König	‘king’
	gewunnen	gewonnen	‘won’
	geswummen	geschwommen	‘swum’

This lowering ability supposes the presence of **A** in Nasals. In the same way, nasalization of vowels by following Nasals generally yields mid nasal vowels, even if the starting point was a high vowel. E.g. in the history of French, the process VN > Ṽ / __{C,#} gave rise to the three French nasal vowels [ɛ̃,ã,õ], none of which is high (cf. alternations such as [fɛ̃] *fin* ‘thin MASC.’ vs. [fin] *fine* ‘thin FEM.’

where the input is [i]). The same evolution under identical contextual conditions has taken place in the history of Slavic. And again, the resulting nasal vowels were all mid or low, even if high vowels were nasalized (see e.g. Trávníček 1935:44ff; Vondrák 1906:335ff).

5.8.5 Summary: Internal structure of Nasals and Liquids
The table in (35) summarizes the results of the preceding sections.

(35) 6.8.1. [r] is **A**-headed (German, English)
6.8.1. **I** contributes to the articulation of [r] (Spanish, Dutch)
6.8.2. [l], [n] and [r] have the same melodic identity (Chaha, Korean, MHG)
6.8.3. [l] and [n] contain **I** (German, Italian)
6.8.4. Nasals contain **A** (MHG > NHG, French and Slavic nasal vowels)

I conclude therefore that [l,r,n] contain **A** and **I**, the former being the head of the structure. This situation raises the question as to what makes these three articulations different. The apex trills when [r] is produced, whereas it does not for [l] and [n]. [n] is nasal, the others are not. Given these properties, I propose that [r] is a trilling [l], whereas [n] is a nasal [l]. Hence, [n] is made of the same primitives as [l] plus **N**. And besides the Elements defining [l], a primitive responsible for the trill of the apex contributes to the production of [r]. It is therefore necessary to introduce a new Element, **T** "trilling apex", that contributes to the articulation of trills and is absent from the internal structure of non-trilling consonants. **T** belongs to a category of marginal primitives that define non-delayed secondary properties of consonants such as ingression, trill or retroflexion. Their distribution is mostly physiologically restricted (e.g. to areas available for the apex as far as trill and retroflexion are concerned).

The phonological identities given in (36) integrate the results arrived at so far and the identities for the various Places of articulation discussed above (**I** contributes palatality, **B** labiality, **U** is head in uvulars, operator in velars).

(36)

Liquids			*Nasals*				
			B				
A	A	A	A	A	A	A	A
I	I	U		I	I	U	U
T			N	N	N	N	N
r	l	ɬ	m	n	ɲ	ŋ	ɴ

Under these provisos, the following generalizations can be stated, allowing for a purely formal definition of the objects 'Nasal' and 'Liquid':

(37) a. Liquids are **A**-headed
b. Nasals contain **A** and **N**

5.9 Sonority

Within the model of consonantal representation introduced, the set of observations referred to as sonority is a mere function of three parameters: 1) the linking of the phonological expression at hand to an Onset or a Nucleus, 2) the presence of the consonantal primitives **ʔ**/**h** and 3) the role played by **A** within the expression (head, operator, absent). The following table summarizes the definition of sonority on purely formal grounds:

(38)

segment	*Nucleus/Onset*	h/ʔ	*role of A*
a	N	—	head
e,o	N	—	operator
i,u	N	—	absent
Liquids	O	—	head
Nasals	O	—	head/operator
Glides	O	—	absent
s,z	O	h	head
gutturals	O	h	head/operator
fricatives	O	h	operator/absent
stops	O	h and ʔ	absent

For example, a sonorant is an object residing in an Onset from which **ʔ** and **h** are absent. A vowel is an object residing in a Nucleus. An Obstruent is a segment residing in an Onset to whose articulation **ʔ** and/or **h** contribute(s).

6. Consonantal interaction: Paradigmatic aspect

Having introduced consonantal representations where the set of observations called sonority receives a phonological expression, let us reconsider the questions on word-initial clusters raised in §4, repeated hereafter for convenience.

(39) a. ***Syntagmatic*** *restrictions*
#CCs that do or do not occur depending on the syntagmatic order of their members: #TR is okay, but #RT out. In clusters of this type, the consonants always contrast in sonority.

b. ***Segmental/paradigmatic*** *restrictions*
There are also CCs of non-contrasting sonority that do not occur word-initially: e.g. *#lr, rl, nl, ln, tp. In these cases, the syntagmatic order of the members does not matter: they are unattested in any order.

Let us first address the latter issue. Consider the situation obtaining for the melodic lines hosting **A**, **I** and **U** within the model of consonantal representation developed above when two consonants occur in a row. "□" indicates the ab-

sence of any primitive. The juxtaposition of an empty and a filled position is noted by "⇐".

(40) a.

	p	r	t	r	k	l	f	r
I/U	□ ⇐	I	□⇐	I	U	I	□ ⇐	I
	|	|	|	|	|	|	|	|
A	□ ⇐	A	□⇐	A	□⇐	A	A	A

b.

	n	r	s	r	ł	r	t	p
I/U	I	I	I	I	U	I	□	□
	|	|	|	|	|	|	|	|
A	A	A	A	A	A	A	□	□

Typical branching Onsets as in (40a) oppose at least one empty and one filled position on a given line. By contrast, (40b) shows consonant clusters that do not occur word-initially for the paradigmatic reasons mentioned (they are *#__ in any order). These never oppose an empty and a filled position on a given line. The representations in (40) of course are only a choice of possible combinations of two consonants. Place limitations preclude an exhaustive survey. The reader may verify that the above statements have general value in Scheer (1996: 320ff).

This distribution relating possible #CCs to the opposition between filled and empty positions leads me to propose the following definition of consonantal interaction:

(41) *Infrasegmental Government (IG)*
Iff a phonological primitive faces an empty position on a given autosegmental line, it may govern this position.

According to (41), the consonant clusters of (40b) can contract no infrasegmental governing relation because either both positions on a given line are occupied ([nr], [sr], [łr]) or both are empty ([tp]).

IG is a development of Harris's (1990) notion of segmental complexity. Harris argues that interconsonantal relations depend on the number of phonological primitives the head and the dependent are made of. The more complex a consonant (i.e. the more primitives it is made of), the better head of a consonantal domain it is, and vice versa. Obviously, IG relies on this notion: a consonant C_1 may govern another consonant C_2 iff C_1 is more complex than C_2. Within the representational framework developed in the previous sections, complexity mainly depends on the presence/absence of **A**, i.e. the vector of sonority.

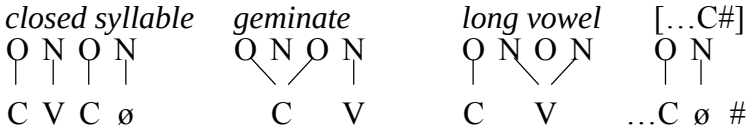
However, this approach would not be any better than the one based on sonority constraints if it could not say **WHY** possible #CCs should depend on consonantal interaction. The distributional relation between the possible consonantal interaction of CCs occurring word-initially and the impossible interaction of CCs that do not occur in this context is nothing more than an **observation**.

Therefore, the next section examines how IG interacts with lateral relations holding between phonological categories.

7. The Phonological ECP, CVCV and the Beginning of the Word

In recent work, the hypothesis assuming a strict CVCV syllabic structure has been evaluated for particular analyses in various languages.[12] The CVCV-model (Lowenstamm 1996) views syllabic structure as a strict consecution of non-branching Onsets and non-branching Nuclei (i.e. no branching constituents, no Codas). For the sake of clarity, consider the representation of closed syllables, geminates, long vowels and the right edge of consonant-final words within this frame:

(42)



All structural information contained in traditional syllabic approaches is preserved. For instance, the site of "closed-syllable" phenomena such as devoicing, lenition, shortening etc. that occur word-finally and before consonants usually receives the uniform description "Coda". In a CVCV approach, these phenomena are referred to as occurring "before an empty Nucleus". The difference between both descriptively equivalent statements is the causal relation between the relevant environment and the observed phenomena. Apart from the general **observation** that Codas are "weak" because e.g. they admit only a subset of possible consonants, there is no reason why segments should devoice, deaspirate, lenite, in short decomplexify in this special position. The correct cross-linguistic observation pointing to the weakness of Codas can only lead to a less surprised reaction when devoicing etc. occurs once more in a Coda-position. It can hardly explain this fact. By contrast, if the Onset is universally viewed as a dependent of the Nucleus like e.g. in Government Phonology, then the fact that objects decomplexify before an empty Nucleus stands in a direct causal relation with the emptiness of the latter. That is, the licensing power of an empty category is smaller than that of a filled category.

A CVCV structure multiplies the number of empty categories, namely of empty Nuclei. This situation raises the more general question of the status of empty categories in linguistics. It seems to be consensual that "you cannot get an empty category for free". This idea is encoded within the Empty Category Principle saying that an empty category may remain unexpressed if and only if precise conditions are met. These conditions are defined in terms of the relation the empty category contracts with a filled position that is laterally distant. In syntax, it was proposed that movement could only take place if the trace of the moved object in its now empty base-position is properly governed by this object in its new position. Proper Government was defined by the structural relation the filled and the empty position contracted (c-command, barriers). This example provides the kind of motivation typical for the existence of empty catego-

ries. If there were no structure preservation, i.e. if the category the object was moved from were deleted or not even present lexically, no explanation along the above lines would be available.

Empty categories do burden the grammar because they request special care (defined e.g. as Proper Government). Nevertheless, their existence is a necessary condition for an explanatory account. Hence, the burdening of the grammar by more empty categories should not be viewed as an undesirable overload, but on the contrary as a welcome source of explanation. If grammar is not free in its moves because it must create or maintain the conditions requested for the existence of empty categories, this constitutes a step towards a more constrained model. The challenge, as for any other scientific theory, is to propose a model that is as constrained as possible while covering all relevant data.

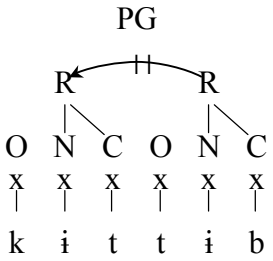
The same reasoning holds for phonology. KLV (1990:219) proposed phonological Proper Government based on the same kind of lateral long-distance phenomena involving an empty and a filled category that led to syntactic Proper Government. In their view, empty categories are subject to the ECP in phonology as well as in syntax. An adapted version of their phonological ECP is given in (43).

(43) *Empty Category Principle*
An empty Nucleus may remain unexpressed iff it is properly governed.

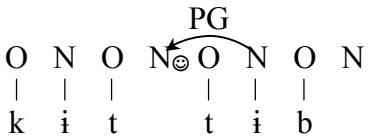
The mentioned long-distance phenomena are vowel-zero alternations that are typically sensitive to the object(s) occurring between the zero (empty Nucleus) and the vowel (filled Nucleus) to its right.[13] Consider e.g. Czech *hudøb-a* 'music NOM.SG.' vs. *hudeb-ní*, **hudøb-ní* 'musical ADJ.' or Moroccan Arabic *køtɨb-ø* 'he writes PF.' vs. *kɨttɨb-ø*, **køttɨb-ø* 'he causes to write'. If both are separated by more than one consonant, the expected zero surfaces as a vowel. The intervening CC-cluster is viewed as a barrier that does not allow the filled Nucleus to properly govern the empty Nucleus, which must therefore appear on the surface.[14]

However, the blocking effect of the "barrier" CC is a pure observational fact that does not follow from anything, see (44a). By contrast, the multiplication of empty Nuclei when assuming a CVCV structure offers a straight forward answer to the question "why do intervening CCs block Proper Government (PG)?":

(44) a. *Non-CVCV: Why do intervening CCs block PG?*

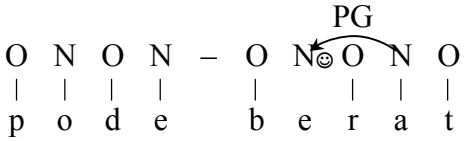


b. CVCV: why do intervening CCs block PG? Because the [CC] encloses an empty Nucleus N☺, /CN☺C/, that seeks PG. PG is not blocked, it simply cannot reach the first [i].



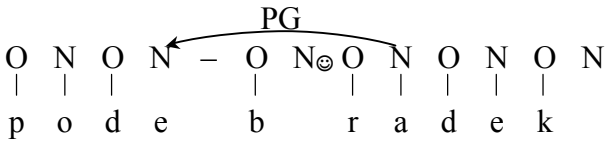
However, intervening CCs do not "block" PG in all circumstances. In Czech prefixes for instance, -e- alternates with zero: *pod**e**-brat* 'seize from below' vs. *pod**ø**-bradek* 'double chin'. The alternation corresponds to a contrast in the lexical structure of the roots involved: /ber/ for [-*br*-*at*] where -e- is properly governable (cf. 1sg [-*b**e**r*-*u*]) vs. /brad/ for [-*brad*-*ek*] where -a- is not properly governable (Scheer 1996; 1997 for a complete demonstration). In the former case, -a- properly governs the -e- of /ber/. As a consequence, the prefixal -e- fails to undergo Proper Government. It therefore appears on the surface (unassociated segments are inaudible).

(45)



By contrast in the case of *podø-bradek*, -a- properly governs the prefixal -ø- although the CC [-br-] stands in between the governor and the governee.

(46)



So far, only two phonological operations that are able to satisfy the ECP have been identified: 1) Proper Government and, in extension of the above definition, 2) Licensing of final empty Nuclei (cf. Kaye 1990). Assuming a CVCV struc-

ture, the empty Nucleus N☺ in cases such as (46) is neither final nor concerned by Proper Government (the -a- governs the prefixal -e-). Nevertheless, it does not surface. Hence, the ECP must be satisfied by another phonological operation. I propose that consonantal interaction as described above can close its domain to the effect that the ECP is satisfied:

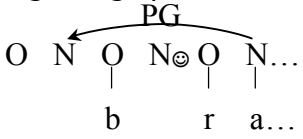
(47) *Phonological operations that are able to satisfy the ECP*[15]
- a. Proper Government
- b. Licensing of final empty Nuclei
- c. Infrasegmental Government:

  The empty Nucleus N☺ of a domain [CN☺C] may remain unexpressed if a relation of Infrasegmental Government holds between its surrounding consonants.

Under these provisos, PG can apply over /bN☺r/ (*podø-bradek*) because the cluster constitutes a domain of IG. By contrast, no domain of IG can be established within the cluster /ber/ (*pode-brat*) since the properly governable /-e-/ prohibits consonantal communication. In this case, PG applies to the nearest target available, that is the /-e-/ mentioned. As a consequence, the prefixal Nucleus fails to undergo PG and receives phonetic interpretation.

In cases like *podø-bradek*, PG by -a- cannot be held responsible for the muteness of N☺ in /-bN☺r-/ because its effect can be seen on the prefix. Lowenstamm (in press) argues that this situation in fact is general even if there is no prefix involved: the first vowel of a word governs what is generally referred to as "#". The phonological identity of the non-linguistic object "#" is an empty Onset followed by an empty Nucleus:

(48) *The beginning of the word: "#" is an empty CV*

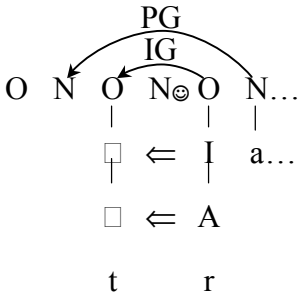


The initial Nucleus being subject to the ECP, it seeks PG from the first vowel of the word. Hence, the first vowel can never properly govern N☺.

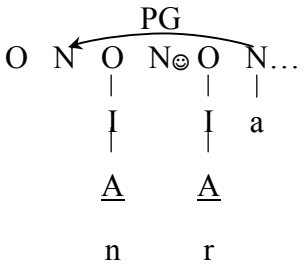
We have now reached the point where an answer to the question raised at the end of the previous section can be provided. It had been shown that impossible word-initial clusters such as #nl, #tp are precisely the ones for which the consonantal identities developed predict that no relation of Infrasegmental Government may hold. Hence, it was tempting to establish a causal relation between both facts saying "a word-initial CC can exist only if it constitutes a domain of Infrasegmental Government". Nevertheless, there was no apparent **reason** why Infrasegmental Government should be a condition on possible word-initial CCs. Assuming CVCV and the phonological identity of "#"=CV, the question "why

are CCs within which no IG holds no possible word-initial clusters?" receives the answer "because the empty Nucleus they enclose is subject to the ECP and IG the only way to satisfy it". As an example, consider the situation for possible #tr as opposed to impossible *#nr:

(49) a. #tr



b. *#nr



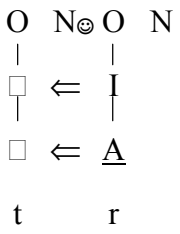
In both cases (49a–b), the ECP concerning the initial empty Nucleus is satisfied through PG by the first vowel of the word. In contrast, only the ECP applying to the N☺ of (49a) is satisfied: [tr] can interact and close their domain, whereas [nr] cannot. (49b) is ruled out because it contains an empty Nucleus, N☺, that is not licensed by any of the phonological operations that may satisfy the ECP.

8. Consonantal Interaction: Syntagmatic Aspect

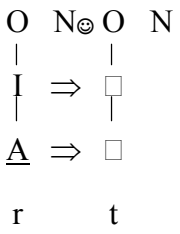
Up to this point, it has been shown that the set of CCs that do not occur word-initially for *paradigmatic* reasons coincide with the set of CCs within which consonantal identities predict that no Infrasegmental Government can hold. Moreover, a causal relation between impossible IG and the non-occurrence of CCs in word-initial position has been established.

I now wish to address the syntagmatic aspect of the restrictions on word-initial clusters: why do consonant clusters of the #TR-kind occur word-initially, but not their mirror-image *#RT? The particular identities of the consonants involved do not matter here because they are identical for the occurring as well as for the non-occurring CCs. In theory, Infrasegmental Government is possible for both #TR (right-to-left) and *#RT (left-to-right):

(50) *Head-final IG*



Head-initial IG

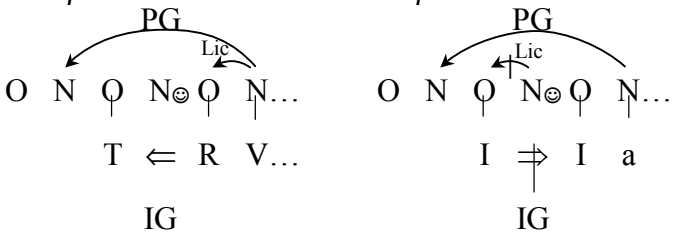


Based on independent evidence, Charette (1990) has noticed that interconsonantal relations depend on the availability of a vocalic support for the head of the consonantal domain. Consider the universal claim Charette makes about interconsonantal relations:

(51) *Government Licensing* (adapted from Charette 1990)
A consonant C_1 can govern another consonant C_2 only if C_1 is licensed to do so by its Nucleus.

Government Licensing was developed within a non-CVCV frame where interconsonantal relations are expressed by means other than Infrasegmental Government and the consonantal identities differ from the ones proposed above. However, the idea expressed by Government Licensing is theory-neutral: in order for a consonantal cluster to exist, its head needs vocalic support. Let us see hereafter which are the predictions made by Government Licensing as to word-initial clusters:

(52) a. *Well-formed structure* b. *Ill-formed structure*



Under the assumption of Infrasegmental Government, R is always the head of the domain of consonantal interaction, and T is the dependent. According to Government Licensing, R needs to be licensed by its Nucleus in order to be able to govern T. In (52a), the Nucleus following R hosts the first vowel of the word. This vowel can license R so that R is able to establish IG over T. In (52b), however, the Nucleus N☺ following R is empty in any event. Hence, it can never license R which, in turn, is unable to govern T. Although the two members of #RT fulfil segmental requirements for an Infrasegmental Government relation, no such relation can be established for syntagmatic reasons. As a consequence, N☺ does not satisfy the ECP, and (52b) is ill-formed.

Charette's Government Licensing thus correctly predicts the non-occurrence of initial *#RT clusters.[16]

9. Conclusion

In this article, I have tried to develop a non-circular alternative to the standard way of handling the distributional restrictions that apply to word-initial consonant clusters. At no point of the argumentation, a constraint intervenes. Rather, the set of **observations** expressed by commonly used constraints such as

"within a branching Onset, sonority must increase" follow from more general principles.

(53) Restrictions on word-initial consonant clusters follow from
  a. Government Licensing (Charette 1990),
  b. segmental complexity (Harris 1990),
  c. the phonological ECP (KLV 1990),
  d. CVCV and "#"=CV (Lowenstamm 1996; in press),
  e. the consonantal identities developed.

All of these devices are assumed to operate in Phonology generally. None of them makes special reference to the particular issue discussed, that is word-initial CCs. For this reason, the approach presented avoids circularity.

Finally, the presented theory of consonantal interaction, unlike constraint-based models, makes the prediction that a world where only word-initial clusters of decreasing sonority occur could not possibly exist.

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Notes

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1 For more discussion of this approach, see for example Clements (1990), Selkirk (1984) and references therein.

2 Cf. Harris's (1994:119) statement about the twofold properties of **A**: Articulations involving **A** "are produced by lowering and retracting the tongue body."

3 In more recent work, efforts have been made in order to account for ATR contrasts in terms of structural oppositions rather than using an independent prime (see for instance the discussion in Harris & Lindsey 1995:62ff). The representation of ATR is not crucial for the purpose of the present paper. For this reason, I will provide no further discussion.

4 More detailed discussion of the vocalic part of this prediction can be found in Scheer (1996:151ff).

5 West-Atlantic language spoken in Guinea. Data from Klingenheben (1941:17).

6 "I propose introducing |**ɯ**| 'velarity' and |**ω**| 'labiality'/'roundness', and dispensing with |u| completely. |u| seems to conflate too many properties anyhow. […] Overall I think it's a good idea for ALL markedness considerations to be excluded from phonological characterizations. […] Segments ought to code only their own properties, not statistics of cross-language distribution".

7 Rennison defines "**U** — pull towards high back tongue body position (but with no implication of lip rounding!)".

8 Abbreviations used in this article: IE = Indo-European, Germ = Common Germanic, Got = Gothic (about 4th century A.D.), OHG = Old High German (about 850–1050 A.D.), MHG = Middle High German (about 1050–1350 A.D.), NHG = New High German (since about the 16th century), Lat = Latin, Gr = Greek.

9 Spirantization occurs in any context except sC-clusters (Got sp,sk,st) and ht,ft (e.g. Lat st̲ella, OHG st̲ërno) and IE [pt̲,kt̲] (e.g. Lat capt̲us, noct̲is, Got haft̲, naht̲s (OHG naht̲ > NHG Nacht̲)). Cf. Paul *et al.* (1989:113f).

[10] There is debate on the status of labials, see Braune & Ebbinghaus (1981:49), Jellinek (1892), Paul *et al.* (1989:113f, 124). The voicing of resulting fricatives is controlled by Verner's Law: iff the fricative is followed by a voiced articulation (=vowel, sonorant, voiced Obstruent) and the preceding vowel it is unstressed in IE, then the fricative is voiced. Otherwise, it is unvoiced (see e.g. Paul *et al.* 1989:123f for illustration).

[11] Of course this does not imply that **A** is the sole defining feature of aspiration, see e.g. Harris (1994:135) for discussion.

[12] See e.g. Lowenstamm (1988; 1996), Guerssel & Lowenstamm (in prep.), Bendjaballah (1995), Creissels (1989), Bonvino (1995), Ségéral (1995), Hérault (1989), Nikiema (1989), Ségéral & Scheer (in press), Larsen (1994; 1995), Heo (1994), Scheer (1996; 1997; 1998a,b).

[13] See e.g. Kaye (1989; 1990), Charette (1990), Scheer (1996; 1997; 1998a,b) for data and analyses concerning vowel-zero alternations.

[14] See e.g. KLV (1990), Kaye (1990), Charette (1990), Scheer (1996; 1997; 1998a,b) on Proper Government.

[15] Other proposals such as Interonset Government and magic licensing, which are discussed in Gussmann & Kaye (1993), Cyran & Gussmann (forthcoming) and Kaye (1992), are not relevant for the purposes of this paper. See Scheer (1998c) for discussion.

[16] Domains of IG are defined in the lexicon. Accordingly, in languages where consonants are lexically unrelated to syllabic constituents, IG does not occur. It is interesting to note that languages allowing for both #TR and #RT clusters are precisely representatives of Afro-Asiatic. These languages have a templatic structure, that is syllabic constituents and segmental information do not co-habit in the lexicon. Lowenstamm (in press) argues for a different status of the initial CV in this kind of languages. According to his analysis, the initial empty Nucleus is not always subject to PG in templatic systems. If this view is correct, then the possible occurrence of both #TR and #RT clusters in templatic languages follows: in #CN☺CV, V properly governs N☺, not the initial CV. Consequently, the surrounding consonants are subject to no co-occurrence restrictions.

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