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Representational complexity in syllable structure and its consequences for Gen and Con

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1. Introduction

The papers in this collection all address some aspect of the following question: In a phonological model developed within the framework of Optimality Theory (Prince and Smolensky 2004), what restrictions, if any, should be placed on Gen, the function that generates a candidate set from a given input form? This paper makes the case that restrictions on Gen must not be considered in isolation; their effects on Con, the constraint set, must be taken into account as well. In particular, allowing Gen a greater degree of freedom in generating subsyllabic structure helps maintain a more restrictive, functionally grounded constraint set.

After a background discussion of the relationship between representational complexity and freedom of analysis, this paper presents an explicit set of representational assumptions about subsyllabic structure (§2) and shows that representational complexity has implications for Con as well as for Gen, in the context of a sonority-based analysis of liquid-specific onset restrictions (§3). Additional syllabification-related predictions of the version of Gen presented here are also considered (§4).

1.1 On freedom of analysis: Ways of restricting Gen

In principle, there are two distinct types of restrictions that can be placed on Gen. First, it is possible to delimit the space of interpretable linguistic representations by establishing an inventory of primitive representational elements and defining the configurations in which these elements can be placed. If Gen is required to produce only output candidates that conform to these specifications, then we can say that Gen is subject to general *representational restrictions*. For example, a particular phonological model might define a set of primitive elements that includes certain distinctive features and certain prosodic categories, and then specify that prosodic categories may dominate categories lower in the prosodic hierarchy (e.g., syllables may dominate moras) but not vice versa.

The second type, which can be called *content-based restrictions* on Gen, are those that exclude from the candidate set particular structures that are otherwise well formed according to whatever representational restrictions are in place. Examples might include a prohibition on the syllabification [CVC.V], or a prohibition on any candidate with more than two epenthetic segments; these restrictions go beyond general representational restrictions if CVC and V have been included in the set of licit syllable types and Gen is permitted to include epenthetic material in output candidates. Often, it is this class of restrictions that linguists have in mind when they debate the merits of freedom of analysis. The standard objection to content-based restrictions on Gen (e.g., Kager 1999: 20; McCarthy 2002: §1.1.3) is that constraint interaction is a better place to search for explanations for universally unattested structures like these, in order to uncover "connections between the universal properties of language and between-language variation" (McCarthy 2002: §1.1.3). Still, it may be that certain types of content-based restrictions on Gen will produce insightful solutions to open questions. Several of the contributions to this collection propose restrictions of this type and explore their ramifications for phonological theory.

The focus of this paper, however, is on the first type of restriction. The argument made here is that in order to decide whether placing a particular representational restriction on Gen really simplifies a phonological model, it is essential to consider the effect of that restriction, not only on Gen, but also on the set of constraints Con. In some cases, it is worth allowing Gen a bit more freedom of analysis if doing so makes for a better-motivated constraint set.

1.2 Representational restrictions and a link between Gen and Con

Restrictions on Gen of the basic representational type are employed, implicitly or explicitly, by essentially all phonologists working in OT (for a recent, explicit example, see McCarthy 2004). The task of determining what the set of primitive linguistic elements should be, and how they should be combined, is a fundamental component of research in linguistics, and has been for many years under many theoretical frameworks. It is generally considered good practice in phonology to add more-complex representations to a phonological model only when the increased complexity is necessary for explaining phonological patterns. From the perspective of OT, keeping representational complexity to a minimum is a way of restricting the parameter space for Gen – the fewer the representational choices that are available to Gen, the smaller the number of distinct candidates that Gen will produce for a given input.

Furthermore, it has been found that working in OT may allow for the simplification of traditional phonological representations. Phenomena that would be used to motivate a complex structural representation in other frameworks can sometimes be recast in OT as the result of simpler representations, interacting with violable constraints whose incomplete satisfaction produces what looks like a complex pattern. Examples of this kind of representational simplification include McCarthy and Prince's (1993b) approach to Tagalog infixation, in which the infix appears to the left of an entire onset cluster, as in /um + gradwet/ –> [gr-um-adwet] 'graduated'. McCarthy and Prince argue that there is no need to posit a representationally defined "Onset" *constituent* under the syllable node, because the apparently constituent-like behavior of the onset cluster [gr] is simply an epiphenomenon of best satisfying the constraint NOCODA. Another example is the re-examination of feature geometry by Padgett (2002), who proposes that constraints that call for the spreading of a feature class (i.e., a node) are not all-or-nothing, but can be only partially satisfied in cases where the demands of a higher-ranked conflicting constraint are at stake. This approach allows for a reduction in the number of feature classes (nodes) that must be included in the model, since not every subset of features that is observed to spread together must be structurally modeled as a constituent.

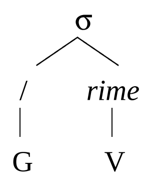
Despite cases like these, however, the use of the simplest conceivable set of phonological representations is not always the best choice, even in the OT framework. This is because there is a mutual relationship between the representational space that Gen can exploit – the structures and configurations that can be present in output candidates – and the types of constraints that make up Con, the constraint set. If a particular model of Con motivates the existence of some constraint *C* that distinguishes between two structural representations *R1* and *R2*, then for *C* to be phonologically active, there must be candidates that differ on the basis of *R1* versus *R2*; that is, Gen must be allowed the freedom to produce both of these structures, or it would be meaningless for Con to include a constraint that distinguishes between them.

The representational question considered here is the syllabification of a glide-vowel (GV) string – how many options does Gen have for assigning syllable structure to GV? A structural distinction between pre-peak glides that are syllabified as true onset segments and those that are syllabified in the rime, as part of a rising diphthong, has been motivated in non-OT models for languages such as French, English, Slovak, and Spanish (Kaye and

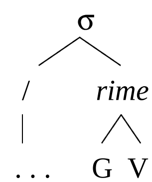
Lowenstamm 1984; Davis and Hammond 1995; Rubach 1998; Harris and Kaisse 1999).

(1) Structural options for glides

a. True onset glide



b. Rimal onglide



When the question of how glides should be represented in syllable structure is reconsidered under OT, one possibility would be to look to constraint interaction to explain why pre-peak glides seem to behave differently in different languages or different contexts, abandoning the representational distinction between true onset glides and rimal onglides shown in (1). If this approach were successful, it would be another representational simplification like those described above for onset clusters and feature geometry, restricting the freedom Gen has to produce different syllabifications for the same segmental string. However, maintaining a structural distinction between true onset glides and rimal onglides under OT has a beneficial theoretical consequence: It allows for an analysis of onset-related sonority patterns based on phonetically motivated constraints, a result that is not possible if all "onset" glides are taken to have the same structural representation.

In summary, the recognition of a structural distinction between onset glides and rimal onglides has certain consequences for the grammar. First, Gen must have the freedom to generate structures that distinguish rime and non-rime segments. Second, there must be constraints in Con that are sensitive to the difference between rime and non-rime segments, or this structural difference would have no phonological consequences. A model of (subparts of) Gen and Con that meets these criteria is developed in §2 below. The importance of this model of syllabification for maintaining functionally motivated constraints is then discussed in §3. Finally, an additional implication of this proposal is that segments other than glides are predicted to appear in the rimal-onglide position; this implication is explored in §4.

In the following discussion, {brackets} indicate the syllable rime, so a true onset glide is represented as G{V}, while a rimal onglide is {GV}.

2. A model of Gen for syllable structure

The claim developed in §3 below, that recognizing two structural positions for glides allows for a more phonetically motivated constraint set, does not depend on the particular formalism by which the rime is represented. Rime segments could be identified on the basis of association to moras, or there could be a structural Rime constituent to which all rime segments belong. What is essential is that there be *some* structural distinction between the two types of glides, to which onset-related constraints can refer. So, for example, this claim is incompatible with the strong version of Blevins' (2003) proposal that phonotactic constraints should generally be stated in terms of segmental strings rather than prosodic structure.

Although various representational models would be compatible with a structural distinction between onsets and rimal onglides, the implications of representational complexity and freedom of analysis cannot be examined without choosing some explicit representational proposal. For concreteness, this discussion assumes a version of moraic theory close to that in McCarthy and Prince (1988) and Hayes (1989), with additional assumptions about prosodic theory as in Selkirk (1978, 1995). Other sets of representational assumptions concerning syllable structure can and should be explored as well. (For recent proposals that recognize an onset/rime distinction without moraic theory, see Zhang 2002; Gordon 2004).

2.1 Gen and allowable syllable shapes

In the model of Gen to be developed here, syllables dominate moras and segments, and moras dominate segments. (Prosodic structure above the level of the syllable is not considered here.) These structural relationships can be enforced if Gen is subject to the restrictions in (2).

(2) Structural restrictions on Gen for syllabification (after McCarthy and Prince 1988; Hayes 1989; Selkirk 1978, 1995)

a. A syllable node (σ) can dominate one or more segments (*X*) and one or more moras (μ)

b. μ can dominate one or more segments (for phonetically motivated arguments in support of "mora-sharing," see Broselow, Chen, and Huffman 1997; Frazier to appear)

c. σ and μ are prosodic constituents and therefore have unique heads (heads are represented by underlining in diagrams)

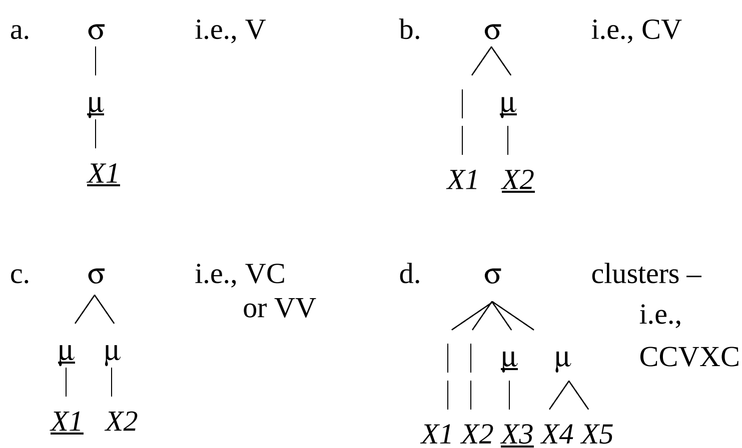
These are representational restrictions, the type of restrictions that define the space of linguistically statable representations. They prevent Gen from including candidates with structures of the following types.

(3) Candidates with the following characteristics are not generated
- a. μ dominating σ, or *X* dominating μ or σ
- b. multiple heads at any prosodic level
- c. moraless syllables, if every prosodic unit must have a head

The representational restrictions in (2) generally seem to be typologically supported; the structures in (3a) are uncontroversially held to be ill-formed, and (3b) is also widely considered to be impossible. There may be some question about (3c), however, since reduced vowels are sometimes treated as moraless (e.g., Hammond 1997, Crosswhite 2004). If it is necessary to relax (3c) somewhat, perhaps Gen can allow for the absence of intermediate prosodic heads as long as there is a terminal head (=segment) for each prosodic constituent.

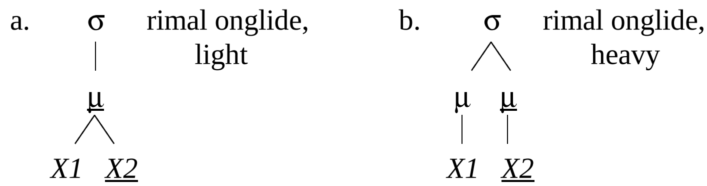
The basic structural restrictions on Gen outlined in (2) allow for the generation of the following types of representations, which are attested syllable structures. (For discussion of structures generated under (2) that may not be as well attested, see the Appendix.)

(4) Structures like the following can be generated



Crucially, these representational restrictions also allow for structures of the following type, where the rime includes a non-head segment that precedes, rather than follows, the head. This type of structure is able to represent a rising diphthong, such as those found in French and Spanish (§1.2).

(5) Rimal onglide structures: rime segments that precede the peak



The structural distinction that Gen can make between the *X1* position in (5ab) and the *X1* position in (4b) under this model of syllable structure is what can be exploited to distinguish between true onset glides and rimal onglides. In order for this distinction to be phonologically meaningful, however, the constraint set must also be sensitive to this structural distinction.

2.2 Gen, Con, and subsyllabic structure

The next step in this exploration of freedom of analysis for syllable structure is to determine, given the syllable-structure criteria for Gen specified in (2) above, the set of subsyllabic structures that can be representationally defined, and therefore referred to by constraints and invoked in formal phonological analyses.

(6) Representationally definable subsyllabic structures

a. **Peak:** The head segment of the head μ of σ is the peak of σ

b. **Rime:** Any segment dominated by μ is in the rime
   - Hypothesis (not pursued here): This includes segments that have additional, non-moraic associations, and segments that are linked to μ but are not its head

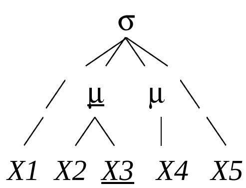
c. **Onset:** Any pre-rime (non-moraic) segment is an onset[1]

d. **Coda:** Various possibilities, subject to empirical verification
   - i. Any ([+cons]?) segment aligned at the right edge of the syllable (McCarthy and Prince 1993a)
   - ii. Any ([+cons]?) segment to the right of the peak
   - – Not all codas are necessarily [+cons]: Syllable-

final glides in Diola Fogny are subject to the Coda Condition (Itô 1988); see also Levi (2004) on glides that trigger vowel epenthesis when unsyllabifiable

The following schematic diagram of a syllable illustrates how segments in various structural positions would be classified according to (7).

(7) Example syllable



X1	true onset
X2	not onset (rimal-onglide position)
X3	peak: head segment of head μ
X2–X4	in rime
X4	coda? (6d–ii)
X5	coda

For present purposes, the most crucial structural distinction to make is that between true onsets, which are dominated directly by the syllable node itself, and other pre-peak segments (e.g., rimal onglides), which are directly dominated by a mora. The constraint definition that needs to be sensitive to this distinction is that for *ONSET/X, a family of constraints that regulate the sonority of "onset" consonants. As demonstrated in §3 below, the segments that are relevant for this constraint family are specifically those that are syllabified in true onset position.

3. Freedom of analysis and onset sonority restrictions

The argument for maintaining the distinction between true onset glides and rimal onglides even within the OT framework comes from languages in which high-sonority onsets are generally avoided, but glide "onsets" are actually permitted. If the glides in question are analyzed as rimal onglides, they are correctly predicted not to be relevant for *ONSET/X constraints, which penalize high-sonority segments syllabified *as true onsets*. Distinguishing between true onset glides and rimal onglides thus allows for a sonority-based treatment of onset restrictions even in cases where glides, the highest-sonority consonant category, are (apparent) exceptions to the restriction.

The advantage of explaining liquid-specific onset prohibitions by means of onset-sonority constraints is that these constraints are functionally motivated. Cross-linguistically, low-sonority onsets are preferred, as shown by evidence from reduplication (Steriade 1982, 1988; McCarthy and Prince 1986) and child language (Gnanadesikan 2004; Barlow 1997). The functional motivation for this preference (see also Gordon 2003) is essentially that a low-sonority onset is more distinct from the syllable nucleus than a high-sonority onset would be (Delgutte 1997; Wright 2004), and the auditory system is particularly sensitive to rapid spectral changes such as an alternation between high- and low-sonority segments (Stevens 1989; Ohala 1992; Delgutte 1997; Warner 1998; Wright 2004).

This cross-linguistic, functionally motivated preference for low-sonority onsets can be modeled in OT by means of the *ONSET/X constraint family, which is based on the *MARGIN/X family (Prince and Smolensky 2004) but applies only to onsets, not to codas.

(8) *ONSET/X ‘Onsets do not have sonority level X’

In order to exploit the distinction between true onsets and rimal onglides in the analysis of liquid-specific onset restrictions developed below, the term “onset” in (8) must specifically refer to true structural onsets, excluding rimal onglides.

The *ONSET/X family consists of one constraint for each level X of the sonority hierarchy. These constraints are in a universally fixed ranking determined by the sonority scale; the constraint against the most sonorous onset is highest ranked.[2]

(9) The *ONSET/X constraint family assumed here
*ONS/GLIDE >> *ONS/RHOTIC >> *ONS/LATERAL >> *ONS/NASAL >> *ONS/OBSTRUENT

The sonority scale arguably includes further distinctions, including vowel height and voicing and continuancy in obstruents (e.g., Dell and Elmedlaoui 1985, 1988), but these distinctions are set aside here because they are not relevant for the languages discussed below.[3]

Because the constraints in the *ONSET/X family are in a fixed ranking, this means that if one *ONSET/X constraint is ranked high enough to be active in some language, so is any higher-ranked *ONSET/X constraint. As a consequence, a ban on onsets with a certain sonority level implies a ban on all onsets with higher sonority. A language that conforms to this prediction is the Sestu dialect of Campidanian Sardinian (Bolognesi 1998), in which both rhotic onsets and the higher-sonority glide onsets are banned in initial syllables.

(10) Prohibition against word-initial rhotic and glide onsets

a. Expected [r]-initial words (Bolognesi 1998: 42)

[arːɔza] ‘rose’ < L. *rosa*	[arːiu] ‘river’ < L. *rivus*
[arːana] ‘frog’ < L. *rana*	[arːikːu] ‘rich’ < It. *ricco*
[arːuβiu] ‘red’ < L. *rubeum*	[arːaðiu] ‘radio’ < It. *radio*
[arːɔða] ‘wheel’ < L. *rota*	

b. Expected [j]-initial words (Bolognesi 1998: 44)

Sestu Campidanian		Iglesias Campidanian (see below)
[ajaju]	‘grandfather’	[jaju]
[ajaja]	‘grandmother’	[jaja]

However, there are a number of languages that ban rhotic onsets, or liquid onsets in general, with no corresponding ban on glide onsets. One example, which will be the focus of the following discussion, is the Iglesias dialect of Campidanian Sardinian (Bolognesi 1998). The Iglesias dialect is a close relative of the Sestu dialect, but differs from Sestu in that only rhotic onsets are banned in initial syllables (see 10b). Another case like Iglesias Campidanian Sardinian is Mbabaram (Australian; Dixon 1991). A related pattern, in which all liquid onsets – rhotics and laterals – are banned in initial syllables, is found in languages such as Mongolian (Poppe 1970; Ramsey 1987), Kuman (Papuan; Trefry 1969; Lynch 1983; Blevins 1994), and the Australian languages Pitta-Pitta and Guugu Yimidhirr (Blake and Breen 1971; Blake 1979; Haviland 1979; Dixon 1980; Smith to appear). Strikingly, many of these onset prohibitions apply only to initial syllables. This is part of a more general phenomenon; initial syllables are often subject to fortition or more stringent sonority requirements than other syllables. A possible case of a liquid-specific onset ban in *all* syllables is Seoul Korean (Kim-Renaud 1986; H.M. Sohn 1994: 440), recent loanwords excepted – but whether this is a case of restricted onsets in all syllables or only in initial syllables depends on whether certain medial liquids are analyzed as ambisyllabic. In any case, at least some of these onset restrictions are restricted to initial syllables (σ1), so we need to invoke a version of *ONSET/X that is positionally relativized: [*ONSET/X]/σ1.[4]

In Iglesias Campidanian Sardinian, rhotic onsets are avoided by means of epenthesis; this motivates the following ranking between DEP 'No epenthesis' (McCarthy and Prince 1995) and the [*ONSET/X]/σ1 constraints.[5] That is, a candidate with epenthesis, violating DEP, is preferred to a candidate with an initial rhotic, violating [*ONS/RHOTIC]/σ1, but all lower-sonority onsets are preferred to a candidate with epenthesis.

(11) [*ONS/GLI]/σ1 >> [*ONS/RHO]/σ1 >> **DEP** >> [*ONS/LAT]/σ1 >> [*ONS/NAS]/σ1 >> . . .

However, the universal ranking of *ONSET/GLIDE above *ONSET/RHOTIC, determined by the sonority scale, means that the ranking in (11) seems to make the wrong prediction for glide-initial words in Iglesias.

(12) Liquids vs. glides in Iglesias Campidanian

a.	[a̲rːɔða]	'wheel'	*[rːɔða]
b.	[jaju]	'grandfather'	*[a̲jaju]

The problem is that ranking [*ONSET/RHOTIC]/σ1 above DEP requires [*ONSET/GLIDE]/σ1 to be ranked above DEP as well, so glide onsets should be avoided through epenthesis just as rhotic onsets are – the pattern that is in fact observed in Sestu, as seen in (10) above, though not in Iglesias.

(13) Banning [r] onsets should make [j] onsets impossible

/rɔða/	[*ONS/GLI]/σ1	[*ONS/RHO]/σ1	DEP	[*ONS/LAT]/σ1
i. rɔða		*!		
☞ ii. a̲rːɔða			*	

	/jaju/	[*ONS/GLI]/σ1	[*ONS/RHO]/σ1	DEP	[*ONS/LAT]/σ1
(☞)	i. jaju	*!			
	✗ ii. a̲jaju			*	

Changing the ranking of DEP so that it dominates [*ONSET/GLIDE]/σ1 does not solve the problem, as the fixed ranking [*ONSET/GLIDE]/σ1 >> [*ONSET/RHOTIC]/σ1 now results in avoidance of epenthesis for rhotic onsets as well as for glides.

(14) Allowing [j] onsets should make [r] onsets possible

/jaju/	DEP	[*ONS/ GLI] /σ1	[*ONS/ RHO] /σ1	[*ONS/ LAT] /σ1
☞ i. jaju		*		
ii. <u>a</u>jaju	*!			

/rɔða/	DEP	[*ONS/ GLI] /σ1	[*ONS/ RHO] /σ1	[*ONS/ LAT] /σ1
✗ i. rɔða			*	
(☞) ii. <u>a</u>rːɔða	*!			

In other words, the universally ranked *ONSET/X scale seems to be at odds with languages like Iglesias in which liquid onsets, but not the more highly sonorous glide onsets, are avoided.

Recognizing a representational distinction between true onset glides and rimal onglides provides a solution to this problem. The proposal to be pursued here is that glides that "escape" sonority-based initial-onset restrictions are rimal onglides, while glides that are subject to these restrictions are syllabified as true onsets. Formally, this requires that we allow Gen to create output candidates that differ with respect to the structural position of pre-peak glides, and that we define *ONSET/X constraints so that they evaluate only non-rimal segments. While this solution requires that Gen be given more freedom in generating syllable structures for output candidates, it has the advantage that the constraints that are responsible for the liquid-specific onset prohibitions, namely, *ONSET/X constraints, remain functionally grounded in the sonority hierarchy. There is moreover additional evidence that sonority is the relevant functional characteristic behind liquid-specific onset bans. Flack (to appear) presents experimental evidence ruling out a "perceptibility"-based account of similar initial-liquid prohibitions in Australian languages, arguing for a sonority-based account instead. Moreover, the languages with liquid-specific onset prohibitions listed above demonstrate an implicational relationship that is compatible with the sonority scale: Lateral bans imply rhotic bans.

There are no alternative analyses of liquid-specific onset prohibitions that are as successful as the onset-sonority approach with respect to the phonetic motivation of the constraints that would be responsible for the pattern. For example, if the model is modified to allow *ONSET/X constraints to be freely ranked in any order, then Iglesias could have the ranking [*ONSET/RHOTIC]/σ1 >> DEP >> [*ONSET/GLIDE]/σ1, which would select the desired candidates. However, this approach is less than appealing because it abandons the relationship between *ONSET/X and the perceptual preference for low-sonority onsets.

Another approach might be to propose a new constraint that simply bans liquid onsets. But such a constraint has no obvious functional motivation. A constraint penalizing liquids that are not post-vocalic might be phonetically motivated for some types of liquids, as there is a cross-linguistic preference for taps, flaps, and trills to occur with a preceding vowel. Crucially, however, some of the liquid-specific onset bans in the languages described above extend to approximant liquids as well, such as [l]. Mbabaram bans even [ɽ] from σ1 onsets – this liquid is realized as "a tap, a trill, or *a rhotic continuant*" (Dixon 1991: 356, emphasis added).

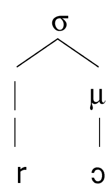
A third alternative might be to assume that glides are subject to onset-sonority constraints just as much as liquids in these languages, as predicted by the *ONSET/X family, but some glide-specific faithfulness constraint intervenes to protect glides from being altered, while liquids remain unprotected (Flack to appear). This approach clearly will not work for Iglesias Campidanian, however, since the initial-rhotic repair is vowel epenthesis. This repair simply violates DEP, not some feature-related faithfulness constraint that might be able to distinguish between rhotics and glides.

Thus, the analysis of liquid-specific onset prohibitions based on the inapplicability of *ONSET/X constraints to rimal onglides is the empirically successful approach that is most consistent with the use of functionally motivated constraints.

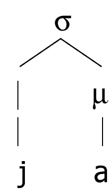
The representational distinction between true onset glides and rimal onglides can be applied to the difference between the Sestu and Iglesias dialects of Campidanian Sardinian as follows. Glides in Sestu pattern with rhotics, so pre-peak glides in this dialect are true onsets.

(15) Sestu: Rhotics and glides both prohibited

a. Rhotics



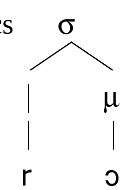
b. Glides



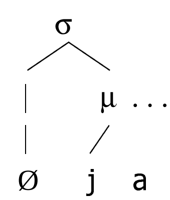
On the other hand, glides in Iglesias are not subject to sonority restrictions, which indicates that they are syllabified as rimal onglides.

(16) Iglesias: Rhotics are prohibited, but glides appear

a. Rhotics



b. Glides



Formally, Iglesias (and the similar cases listed above) can be analyzed as follows.

(17) The ban on [r] onsets motivates [*ONS/RHOTIC]/σ1 >> DEP

/rɔða/	[*ONS/ GLI] /σ1	[*ONS/ RHO] /σ1	DEP	[*ONS/ LAT] /σ1
i. rɔða		*!		
☞ ii. a̲rːɔða			*	

(18) Syllabifying [j] as rimal onglide satisfies [*ONS/GLIDE]/σ1

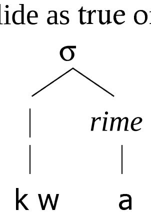
/jaju/	[*ONS/ GLI] /σ1	[*ONS/ RHO] /σ1	DEP	[*ONS/ LAT] /σ1
☞ i. {ja}ju	✓		✓	
ii. j{a}ju	*!			
iii. <u>a</u>jaju			*!	

The presence of syllable-initial glides in this dialect does not entail that *ONSET/GLIDE is violated, because the glides are rimal onglides. Thus, Iglesias is now compatible with the typological prediction that satisfaction of *ONSET/RHOTIC implies satisfaction of *ONSET/GLIDE.

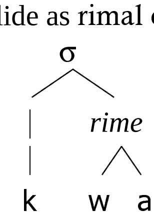
There is additional evidence in support of the claim that Sestu and Iglesias syllabify "onset" glides differently, as these two dialects treat glides differently in another context as well: Iglesias allows rising diphthongs with an onset consonant (CGV), but Sestu does not. As Bolognesi (1998: 24) states, "Rising diphthongs . . . are normally prohibited in Sestu . . . [T]he 'Standard' Campidanian word 'kwaɖ̤u ('horse') is realized as ku'aɖ̤u in the Sestu dialect: /u/ is short and unstressed, but distinctly longer than the corresponding glide." Given the structural distinction between true onset glides and rimal onglides, there are two possible structures for a CGV syllable.

(19) CGV syllables – Possible structures

a. Glide as true onset



b. Glide as rimal onglide



The fact that Sestu disallows CGV syllables means that its phonological system must rule out both (19a) and (19b). Iglesias, which allows CGV syllables, must allow either (19a) or (19b). These conclusions are compatible with the current proposal based on onset-sonority restrictions: only

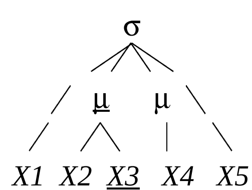
Campidanian allows rimal onglides. (An additional explanation is needed for why Sestu also disallows the structure in (19a), but this question is separate from the claim made here, which is that *if* the rimal onglide structure {GV} is allowed, *then* the structure [C{GV}] should also be allowed.)

In summary, the account developed here invokes the functionally motivated *ONSET/X constraints to account for liquid-specific onset restrictions. For this approach to work, *ONSET/X must evaluate the sonority of true onsets but not of rimal onglides, thereby allowing a language the option of obeying *ONSET/GLIDE by syllabifying pre-peak glides as rimal onglides. Because Con is sensitive to the structural distinction between onset glides and rimal onglides, Gen must have the freedom to produce candidates with both types of structures.

4. Further implications of this model of Gen for syllabification

The diagram in (7) above, repeated here as (20), exemplifies the kinds of subsyllabic structures that can be defined given a model of Gen operating under the representational restrictions stated in (2).

(20) Example syllable



X1	true onset
X2	not onset (rimal onglide position)
X3	peak: head segment of head μ
X2–X4	in rime
X4	coda?
X5	coda

Based on cross-linguistic facts about syllabification, we know that there are no universal restrictions on what segment classes can be parsed as syllable peaks (Dell and Elmedlaoui 1985, 1988; Prince and Smolensky 2004); as weight-bearing codas (Hayes 1989; Zec 1994); or as onsets (with the possible exception of low vowels; see Rosenthall 1994 for discussion). Because there exist languages that allow all segment classes to be syllabified in these positions, there can be no restrictions on what segments Gen is allowed to prosodify into these syllable positions. Of course, there are well-known *language-particular* restrictions on the segment classes that can fill these positions, but these can (must) be modeled in terms of constraint interaction, not restrictions on Gen.

These facts about segment classes and freedom of analysis, coupled with the formal implementation of syllable structure adopted here, have certain consequences for the rimal-onglide structure. The general representational conclusion to be drawn from the discussion in §3 above is that Gen allows a segment *X* to be syllabified in the rimal-onglide position. So far, the discussion has considered only glides ([–cons] segments) in this position. But can segments in this position ever be [+cons]? As noted above, rime sub-constituents (such as weight-bearing codas) and even syllable peaks can be [+cons] segments in many languages. Thus, there is no general restriction on [+cons] segments in the rime. This predicts that there should be languages in which the segments syllabified into the 'rimal onglide' position include consonants.

What might evidence for [+cons] segments in the rimal-onglide position look like? One scenario in which consonants might be syllabified as rimal onglides would be under compulsion from *COMPLEXONSET, the constraint against onset clusters. Strong evidence for the ability of *COMPLEXONSET to force consonants into the rime would be a language in which all CV syllables are light, but all CCV syllables are heavy, parallel to light G{V} versus heavy C{GV} in Spanish (Harris and Kaisse 1999). This weight pattern would show that the second C in CCV is weight-bearing, and therefore must be rimal. However, as decades of research into interactions between onsets and stress have shown, there are very few languages in which onsets, or onset clusters, have any effect on stress assignment at all.

Another type of evidence for consonants in the rimal-onglide position due to *COMPLEXONSET would be a language that also has restrictions on rimal segments (including those in the rimal-onglide position), requiring them to be high in sonority. The combined effect of these two markedness constraints would be a language with C_1C_2 "onset clusters" where C_2 must be some high-sonority element, but does not have a fixed sonority *distance* from C_1 (as we would expect to see in a true onset cluster). This would be analogous to another fact about Spanish: C_1C_2 onset "clusters" have no sonority-distance restrictions if and only if C_2 is a glide (Baertsch 1998) – as predicted, since a glide in the C_V context is a rimal onglide in Spanish.

Evidence for the rimal status of pre-peak consonants might also be found in a language that takes the Iglesias Campidanian pattern one step farther, such that high-sonority segments other than glides are also driven into the rimal-onglide position by *ONSET/X constraints. Stress-related evidence for a pattern of this type may exist: Davis, Manganaro, and Napoli (1987) argue that Italian second-conjugation infinitive verbs treat the antepenultimate syllable as heavy *if its onset is a sonorant*. This example appears to be morphologically restricted, but even so, it may be a case of *ONSET/X constraints for X ≥ NASAL forcing pre-peak sonorants into the rime.

Also suggestive in this context is the claim that speech-error patterns in Japanese (Kubozono 1989) support a model of prosodification in which all "onset" (pre-peak) segments are dominated by a mora (essentially, the version of moraic structure in Hyman 1985). If this interpretation of the speech-error data is phonologically relevant, then Japanese may be a language in which all *ONSET/X constraints are satisfied by consistently syllabifying pre-peak segments into the rime. Syllable weight is extremely significant in many aspects of Japanese phonology and prosodic morphology, so it is well established that pre-peak consonants do not contribute to syllable weight. However, this fact alone does not prove that said consonants are not rimal; monomoraic {GV} is attested (light rising diphthongs), so monomoraic {CV} is predicted to occur as well if [+cons] segments can appear in the rimal onglide position.

These intriguing examples from Italian and Japanese aside, if it turns out that [+cons] segments cannot be syllabified in the rimal onglide position, then the reason for this systematic gap remains an open question; perhaps it calls for content-based restrictions on freedom of analysis in addition to the basic representational restrictions in (2), or perhaps it is an effect of the interface between grammar and diachronic change (Myers 2003).

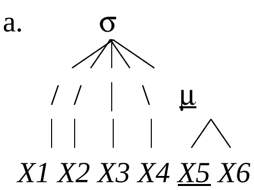
6. Conclusion

Empirical and OT-internal evidence support a model in which Gen and Con distinguish true onset glides from rimal onglides. Complicating output representations with subsyllabic hierarchical structure in this way, so as to recognize two structural positions for pre-peak glides, is motivated because it allows for an account of onset restrictions that relies on cross-linguistically attested, phonetically grounded constraints. Additionally, under freedom of analysis – based on the cross-linguistic space of possibilities for assigning segments to rimal positions in the syllable – we seem to predict that consonantal segments should be able to appear in the rimal-onglide position as well; some evidence in support of this claim is available, but more investigation is needed. In any case, at least for glides, a model that takes into account the implications of representational complexity for both Gen and Con must allow Gen the freedom to syllabify pre-peak glides as either onset or rimal segments, since the best model of Con with respect to onset sonority restrictions distinguishes these two representational options.

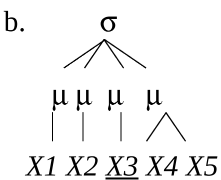
Appendix: Slightly too much freedom of analysis?

The basic representational restrictions on syllabification proposed in (2) above generate the well-formed structures in (4) and (5), while correctly ruling out the universally problematic structures in (3). However, this model of Gen produces the following structures as well, which may not be attested.

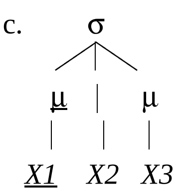
(21) Additional structures produced by Gen according to (2)

a. 

clusters with many *X*s

b. 

σ with >3 µ

c. 

*X*s between moras

If these structures are allowed by Gen, and yet universally unattested, then what is responsible for ruling them out? Super-complex clusters as in (21a) can be ruled out in individual languages on the basis of constraints involving sonority-distance requirements or perceptibility considerations. But what accounts for the complete absence of such structures – is this a further example of a gap in factorial typology with a diachronic explanation (Myers 2003)? The case in (21b) is a familiar puzzle in moraic theory; there cannot be a universal bimoraic limit, as superheavy (trimoraic) syllables are attested, though comparatively rare. So why stop at *three* moras?

The structure in (21c) is not something that has received much attention in the literature, but it is quite clearly generated under the representational restrictions stated in (2), which have nothing to say about the relative ordering of segments and moras under a syllable node. Even if we add additional complexity to the current model of syllable structure and recognize a Rime node in addition to moraic structure, it is unclear what would prevent a segment from intervening *between* moras. One possible approach might be requirement that Gen keep moras contiguous within a syllable – but this would be a content-based restriction on Gen, not a basic representational restriction, and so perhaps other solutions should be considered first (although the questionable status of the intermoraic segment in (21c) is suspiciously reminiscent of the edge-orientation of extrametrical elements). Conversely, the structure in (21c) may not be impossible at all, if this is an appropriate representation for intrusive (*svarabhakti*) vowels (see Hall 2004 for a recent review and discussion under a different representational framework).

Acknowledgments

Discussion of the Sestu and Iglesias epenthesis patterns, and the advantages of distinguishing true onsets from rimal onglides, also appears in Smith (2003, 2005). I am grateful to Patrik Bye for encouraging me to revisit this topic from the perspective of freedom of analysis. Also, many thanks to Ian Clayton, Melissa Frazier, Elliott Moreton, and participants in the "Freedom of Analysis?" workshop for helpful comments and suggestions.

Notes

1. A consequence of this definition of "onset" is that the constraint ONSET does not actually require the presence of a *true* onset; it is satisfied as long as the syllable peak is preceded by any tautosyllabic segment (Smith 2005, to appear).

2. See also Prince (2001) and de Lacy (2002) for another approach to linguistic scales based on stringency constraints. The points made here can be recast in the stringency model; see Smith (to appear) for discussion.

3. For recent discussion and experimentation related to the sonority scale, see Parker (2002) and Wright (2004).

4. See Smith (2005) for a general theory of markedness constraints relativized to phonologically prominent positions.

5. ONSET 'Syllables have onsets' must also rank below [*ONSET/RHOTIC]/σ1, or the epenthetic #V in the winning candidate would be avoided.

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