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Sonority Is Different*

Abstract

The paper argues that sonority on the one hand and other segmental properties such as place of articulation (labiality etc.) and laryngeal properties (voicing etc.) on the other hand are different in kind and must therefore not be represented alike: implementations on a par e.g. as features ([±voc], [±son], [±lab], [±voice] etc.) are misled. Arguments come from a number of broad, cross-linguistically stable facts concerning visibility of items below and above the skeleton in phonological and morphological processing: sonority, but no other segmental property, is taken into account when syllable structure is built (upward visibility); processes located above the skeleton (infixation, phonologically conditioned allomorphy, stress, tone, positional strength) do make reference to sonority, but never to labiality, voicing etc. (downward visibility). Approaches are discussed where sonority is encoded as structure, rather than as primes (features or Elements). In some cases not only sonority but also other segmental properties are structuralized, a solution that does not do justice to the insight that sonority and melody are different in kind. Also, the approaches that structuralize sonority are not concerned with the question how the representations they entertain come into being: representations are not contained in the phonetic signal that is the input to the linguistic system, nor do they fall from heaven – they are built by some computation. It is therefore concluded that what really segregates sonority and melody is their belonging to two distinct computational systems (modules in the Fodorian sense) which operate over distinct vocabularies and produce distinct structure: sonority primes are used to build syllable structure, while other computations take other types of primes as an input. The computation carrying out a palatalization for example works with melodic primes. The segment, then, is a lexical recording that has different compartments containing domain-specific primes [<sonority>, <melody>]$_{\text{SEGMENT}}$. This is also the case of the morpheme, which hosts three compartments [<morpho-synt>, <sem>, <phon>]$_{\text{MORPHEME}}$.

Keywords

sonority, modularity, features, Elements, two phonologies, segment laryngeal properties, place of articulation

1. Introduction

Major class distinctions embodied in the sonority hierarchy oppose vowels and consonants, within consonants obstruents and sonorants and sometimes more fine-grained categories among the latter, i.e. nasals, liquids and glides. The pages below are about the difference in behaviour, and hence in ontology and representation, of this type of segmental properties (referred to as *sonority* below) with respect to other segmental characteristics, i.e. place of articulation (labiality etc.) and laryngeal properties (voicing etc.). These will be referred to as *melody*.[1] Traditionally, melodic properties of the segment as well as those pertaining to its sonority are expressed by features ([±voc], [±lab], [±voice] etc.) in the same feature matrix (SPE) or by constraints on (single) features in the same constraint ranking (OT).

On the pages below it is argued that this practice is misled: sonority is different in kind and therefore must not be represented like labiality or voicing. In order to show that a number of broad, cross-linguistically stable facts are discussed: each one is well studied, but as far as I can see to date they have not been condensed into an argument showing that sonority is different (from melody – different in kind). The points made concern visibility of items below and above the skeleton in phonological and morphological processing. On the one hand (upward visibility) sonority, but no other segmental property, is taken into account when syllable structure is built (syllabification algorithm, section 2). On the other hand (downward visibility) processes located above the skeleton do make reference to sonority, but never to labiality, voicing and the like: relevant cases discussed in section 3 are infixation, phonologically conditioned allomorphy, stress, tone and positional strength.

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[1] Whether laryngeal properties may or should be subsumed under the heading of sonority is debatable. Motivated among other things by lenition trajectories that move along the sonority scale but also involve voicing steps (p > b > v etc.), sonority scales usually include voicing, aspiration etc.: voiceless aspirated stops > voiceless unaspirated stops > voiced stops > fricatives > etc. (Szigetvári 2008; Parker 2011: 1177 counts 17 different categories). However, all diagnostics provided by the phenomena discussed in section 2 and 3 show that laryngeal properties have nothing to do with sonority: they are not taken into account by the computation that builds syllable structure (section 2, note 3). Since laryngeal properties are thus not projected above the skeleton, they cannot be taken into account by processes that are located in this area, which are therefore blind to them: infixation, phonologically conditioned allomorphy, stress, tone and positional strength of post-coda consonants. These are all discussed in section 3.

Whatever the workings of those phenomena that have led to the presence of laryngeal properties in the sonority hierarchy (on which more in section 5.4), the empirical evidence mentioned, both from bottom-up (syllabification) and top-down computation (the other phenomena at hand), show that there is a phonologically relevant and cross-linguistically stable set of distinctions that excludes laryngeal properties. For want of a better term that is not overlapping with laryngeal properties in phonological lingua franca, below this set is called sonority.

The insight that sonority and melody are different in kind is made explicitly or implicitly by representationally oriented theories originating in Standard Government Phonology (SGP) where sonority is structuralized. That is, sonority is conceived of as a structural property of the representation, rather than as a prime (features or Elements). Different incarnations of this idea are discussed in section 4 (Feature Geometry, complexity in SGP, GP2.0, Onset Prominence, Radical CV Phonology, Carvalho's contour-based representations). Section 5 shows that structuralizing other segmental properties on top of sonority (as is the case in GP2.0 and Carvalho's model) does not help doing justice to the insight that sonority and melody are different in kind: they are as much indistinct when they are both structure as when they are both segmental primes (section 5.1).

Also, the approaches mentioned where sonority is structuralized in one way or another are not concerned with the question how the representations they use come into being: representations are not contained in the phonetic signal that is the input to the linguistic system, nor do they fall from heaven. They are built by some computation. Section 5.2 therefore concludes that what really segregates sonority and melody is their belonging to two distinct computational systems (modules in the Fodorian sense) which operate over distinct vocabularies and produce distinct structure: sonority primes are used to build syllable structure, while the computation of melodic primes results in segmental structure (i.e. structure below the skeleton). Finally, sections 5.3 to 5.5 sketch the workings of a system where sonority and melody belong to two distinct vocabularies, are segregated in two compartments of the lexical recording of segments ([<sonority>, <melody>]) and accessed by different computational systems: the one building syllable structure only works on <sonority>, another responsible for melodic computation (e.g. palatalization) taking <melody> as an input.

The article is a piece of a broader project whose goal is to show that morpho-syntactic computation and phonological melody are entirely incommunicado, in both directions. Sonority has parasitic effects in this endeavour since it appears to ruin the generalization on a number of occasions. It therefore needs to be understood that sonority is not melody. The overall (empirical and pre-theoretical) generalization that is aimed at is called *melody-free syntax (and morphology)* in reminiscence to Zwicky and Pullum's (1986) influential slogan *phonology-free syntax*, which turns out to be too strong a claim.[2]

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[2] The idea that morpho-syntax and melody are mutually incommunicado is developed in Scheer (2011a: §§412, 660) as well as in a number of conference presentations since Scheer (2012b) and in Scheer (2016) regarding phonologically conditioned allomorphy.

2. Sonority is projected, melody is not

Given relevant parametric settings for a given language (determining whether or not specific syllabic configurations such as codas, branching onsets etc. are provided for), syllable structure is a function of two and only two factors: the linear order of segments and their relative sonority. The syllabic parse of, say, tr and rt is not the same in languages such as English or Spanish that allow for branching onsets because tr is a good branching onset (but rt is not), owing to its rising sonority slope. Having a rising sonority slope involves both factors mentioned: in order for a cluster C_1C_2 to be a good branching onset C_1 and C_2 need to have distinct sonority (relative sonority: r and l are of equal sonority and thus will not form a branching onset no matter in which order they occur), and this sonority difference needs to form a rising slope (linear order: rt has a good relative sonority difference but a falling slope and therefore does not qualify).

That syllable structure depends on these two factors (plus parametric settings) and on no other is an undisputed and theory-independent fact which is transcribed in all syllabification algorithms (e.g. Steriade 1982: 72ff; Blevins 1995: 221ff; Hayes 2009: 251ff).[3] In other words, sonority is projected at the syllabic level (where syllable structure lives, i.e. above skeletal slots in a regular autosegmental representation), but melody is not. This is also obvious from visibility: suppose you sit in the syllabic area and have no access to whatever occurs below skeletal slots – what kind of information about segmental structure will you be able to retrieve (or predict)?
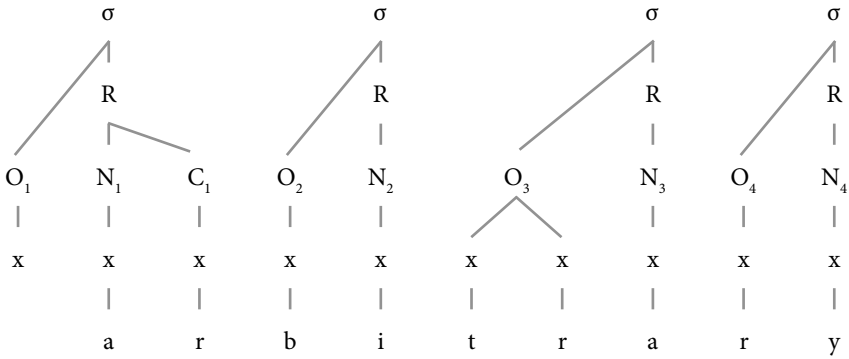
From this position, the word *arbitrary* represented under (1) provides the following information.[4] The broadest segmental property identifiable is the distinction between consonants and vowels: the content of O and C belongs to the former, the content of N to the latter category. In addition the observer knows that C_1 is at least as sonorous as O_2. Compare this information with the one provided by the host of O_4, whose sonority, absolute or relative with respect to neighbours, could be anything. By contrast, the sonority slope of the two consonants contained in O_3 may be predicted: its first member must be

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[3] The diagnostic provided by syllabification indicates that laryngeal properties are not a piece of sonority: there are no cases on record where, say, a cluster made of a voiced and a voiceless stop, or of a stop and voiced fricative (but not of a stop and a voiceless fricative) makes a good branching onset. The only thing that appears to be taken into account by syllabification are major class distinctions, i.e. between obstruents, sonorants and vowels, sometimes split into further categories among sonorants (nasals, liquids, glides, see note 5) – but never involving laryngeal properties.

[4] Representations used in this article are as theory-neutral as possible. Therefore phonological lingua franca is used, i.e. what appears to be the minimal autosegmental common denominator. No argument made hinges on theory-specific assumptions.

less sonorous than its second member.[5] Finally, if the emptiness of constituents is information available, the observer will know that the word is vowel-initial and vowel-final.

(1)   visibility from above

$$
\begin{array}{cccccccccc}
\sigma & & & \sigma & & & \sigma & & & \sigma \\
\end{array}
$$

	R			R			R		R
O_1	N_1	C_1	O_2	N_2		O_3	N_3	O_4	N_4
x	x	x	x	x	x	x	x	x	x
a	r	b	i	t	r	a	r	y	

Given this situation, it does not come as a surprise if processes that are located at and above the skeleton are blind to melodic properties: these are simply unavailable because they are not projected. Relevant processes include phonological computation of supra-skeletal properties such as stress, tone and the definition of positional strength, but also morphological computation such as infixation and phonologically conditioned allomorphy. As is shown in the sections below, sonority is a factor in all of these processes, which are however blind to melody.

3. Sonority, but not melody, is visible from above: empirical evidence

3.1. Infixation

Typological surveys of infixation include Moravcsik (2000) and Yu (2007). The latter studied 154 infixation patterns in 111 languages belonging to 26 different phyla and isolates. Based on this record, Samuels (2009: 147ff) provides an overview of phonological factors that are known to condition infixation. The list of anchor points that infixes look at in order to determine their landing

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[5] The more fine-grained content of branching onsets is language-specific: some languages restrict them to obstruent + liquid (excluding obstruent + glide like in the Proto-French case discussed in section 3.1), others include glides in second position (Modern French), while still others (like German) also include (some) obstruent-nasal combinations (kn, gn). Hence to know the precise content of branching onsets, the observer needs to know about relevant parameter settings of the language. But in any case the sonority slope in a branching onset will rise.
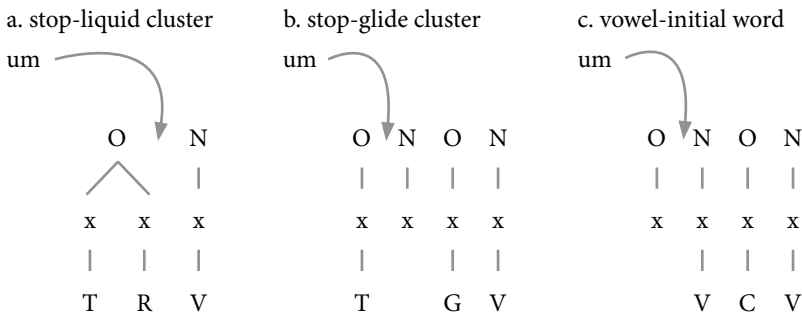
site falls into two categories: edge-oriented and prominence-oriented. For the left edge for example, documented situations are "after the first consonant (or consonant cluster)", "after the first vowel", "after the first syllable" and "after the second consonant." Prominence-based attractors are stressed vowels, stressed syllables or stressed feet.

As may be seen, in no case is melody reported to be relevant for the definition of the landing site. Hence cases where infixes are inserted after, say, the first labial consonant of the word (and in absence of labials are prefixed) do not appear to be on record.[6] Phonological conditioning factors are located exclusively at and above the skeleton.

In this context, the Tagalog pattern (Austronesian, Philippines) studied by Zuraw (2007) is instructive since it shows that sonority may also be taken into account when the landing site of infixes is determined. In Tagalog, the *um* infix is inserted after the first consonant of words: the infixed form of *labusaw* 'made turbid' is *lumabusaw*. Since Tagalog does not have native cluster-initial words, speakers must make a decision to insert the infix either after C_1 or C_2 when applying native morphology to cluster-initial loans. For example, English *graduate* could come out as either *gumraduate* or *grumaduate*. Zuraw reports that *um* splits word-initial stop-glide clusters significantly more often than stop-liquid clusters. Hence sonority-defined cluster types seem to impact infixation.

If stop-liquid clusters are syllabified as branching onsets but stop-glide clusters do not qualify for this status and end up as two separate onsets (or some other structure involving an appendix or an extrasyllabic consonant), the infix simply lands after the first onset of the word, as under (2)a,b.[7] That is, computation looks only at properties that are available at and above the skeleton.

(2)   Tagalog sonority-driven infixation

a. stop-liquid cluster   b. stop-glide cluster   c. vowel-initial word

um   um   um

O   N   O   N   O   N   O   N   O   N

x   x   x   x   x   x   x   x   x   x   x

T   R   V   T   G   V   V   C   V

The fact that obstruent-sonorant clusters may build branching onsets while obstruent-glide clusters do not is a known pattern. For one thing, this is what the traditional notion *muta cum liquida* conveys: clusters are specific and solidary when liquids follow obstruents. In the evolution from Latin to French for example, post-obstruent glides were heterosyllabic and hence in strong position, while liquids in the same context were tautosyllabic (see e.g. Bourciez and Bourciez 1967: §§144f, 168f, 171). Yod in strong position strengthened to Old French tʃ / dʒ (> Mod. Fr. ʃ / ʒ): Lat. *r<u>a</u>bia* > **rab.ja* > Fr. *ra[ʒ]e* 'rage', Lat. *s<u>a</u>piam* > *sap.ja* > Fr. *sa[ʃ]e* 'to know subj. 3sg', Lat. *l<u>e</u>viu* > **lev.ju* > Fr. *liè[ʒ]e* 'cork' (tonic vowels are underscored). The original obstruent is regularly lost in coda position (like in Lat. *r<u>u</u>p.ta* > Fr. route 'road'), and the preceding tonic vowel confirms the heterosyllabicity of the cluster: Lat. a becomes *e* and *e* goes to *ie* in open syllables (Lat. *m<u>a</u>re* > Fr. *mer* 'sea', Lat. *f<u>e</u>ru* > Fr. *fier* 'proud'), but the respective results in closed syllables are *a* (Lat. *c<u>a</u>rta* > Fr. *charte* 'charter') and *e* (Lat. *h<u>e</u>rba* > Fr. *herbe* 'grass'). Thus in all cases at hand, the tonic vowel shows the behaviour of a checked vowel.

In the same position, liquids on the other hand do not strengthen, and the tonic vowel diagnostic shows that the cluster is tautosyllabic. Hence Lat. *lep(o) re* > Fr. *lièvre* "hare", Lat. *c<u>a</u>pra* > Fr. *chèvre* 'goat', Lat. *p<u>e</u>tra* > Fr. *pierre* 'stone'. All vowels preceding *muta cum liquida* thus show unchecked behaviour.

Zuraw (2007: 299) also reports that vowel-initial words are "infixed" before the first vowel: *abot* 'attain' produces *umabot*. She attributes this landing site to the existence of an epenthetic glottal stop at the outset of vowel-initial words: *abot* in fact is *ʔabot*, and the infixed form *ʔumabot*. One may wonder whether the glottal stop, being epenthetic, is present or visible by the time the landing site of the infix is computed. If *um* lands after the first onset, the correct form is produced also in absence of the glottal stop: *abot* begins with an empty onset, and *um* lands to its right like everywhere else, as shown under (1c).

3.2. Phonologically conditioned allomorphy

The selection of allomorphs, i.e. independently stored variants of the same morpheme, may be conditioned by purely morpho-syntactic factors (like in the case of *go* and *went*, selected according to tense), but phonological properties may also play a role. A case in point is Moroccan Arabic where the 3sg masculine object/possessor clitic is *-h* after V-final, but *-u* after C-final stems.

Paster (2006) has surveyed about 600 languages and described 137 cases of Phonologically Conditioned Suppletive Allomorphy (PCA) in 67 languages. Chapter 2 of her Ph.D. is about segmentally conditioned PCA, chapter 3 is concerned with tone- and stress- conditioned PCA, while chapter 4 reviews prosodically conditioned PCA. In chapter 2, relevant for our purpose, Paster mentions 72 cases of PCA from 32 different languages. These fall into two major groups: a large set where the conditioning factor is consonant- vs. vowelhood (like in the Moroccan Arabic case mentioned), and a number of cases where

sonority is the driving factor. The latter includes Kwamera (Central-Eastern Oceanic) where prefective *in-* occurs before stems beginning with non-high initial vowels, while *uv-* is observed before consonant-initial stems and stems that begin with a high vowel.

All these cases are found in the chapter on segmental conditioning, but in fact concern only sonority. This is also true for C vs. V conditioning, which is based on a major class distinction that is legible anyway at the syllabic level where consonants and vowels belong to different constituents.[8]

Scheer (2016) discusses the empirical situation in greater detail, and reviews relevant literature. All in all seven cases where melody seems to be truly responsible for allomorph selection could be identified. One is found in Hungarian, where present tense indef. 2sg is realized *-s* everywhere, except after sibilant-final stems where *-El* is found (*E* is a harmonizing vowel whose melodic content is determined by vowel harmony).

All cases of this kind turn out not to represent allomorphy since they may be reduced to a single underlying form for the morphemes in question by the floating segment analysis. In the Hungarian pattern described, the regular (elsewhere) consonant *s* is lexically associated to its syllabic constituent, while the consonant that occurs only in a specific environment, *l*, is also present but floats (3a). In regular concatenation only *s* will be pronounced, (3b) but the attachment of *s* to a sibilant-final root creates an illegal cluster of two sibilants. The lexically associated *s* therefore delinks and the floating *l* takes its place (3c). The presence of the harmonizing vowel is automatic and predictable since word-final C*l* clusters do not occur in the language (but C*s* clusters do) and are thus broken up by a vowel whose identity is determined by way of vowel harmony.[9]

(3)   Hungarian s / El

| a. lexical identity | b. after regular stems | c. after sibilant-final stems |

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[8] Here again laryngeal properties are irrelevant: PCA may make reference to major class distinctions, but no cases are on record where laryngeal properties are concerned. PCA thus confirms the diagnostics provided by syllabification (note 3) and infixation (note 6): laryngeal properties cannot be read off syllable structure because they are not projected in the first place.

[9] There is no particular reason why the illegal sibilant-sibilant cluster is repaired by modifying the suffix consonant, rather than by inserting an epenthetic (harmonizing) vowel in its midst (or by some other repair for that matter). Here not any more than elsewhere, possible repair strategies are not predictable.

All in all phonologically conditioned allomorphy overwhelmingly appeals to factors that are available above the skeleton: tone, stress, prosody and sonority. Melody plays no role except in a handful of cases which may all be reduced to purely phonological workings based on a single underlier.

3.3. Stress

Stress placement is known to be conditioned by syllable structure: so-called Weight-by-Position regulates whether or not closed syllables count as heavy. That is, languages parametrically choose whether codas do or do not make a syllable heavy (Hayes 1989). Weight-by-Position, however, allows for more fine-tuning: in some languages sonorant, but not obstruent codas contribute to the weight of their syllable. Documented cases of this pattern are found in native American Wakashan languages (e.g. Wilson 1986; Zec 1995: 103ff; Szigetvári and Scheer 2005: 44f, see the typological survey in Gordon 2006). Hence syllable structure (codas) and sonority may impact stress assignment – but there is no case on record where, say, labiality has this effect ("a coda is heavy only if it is labial").[10]

On the vocalic side, de Lacy (2002) and Gordon (2006: 52) have established the same generalisation, which is also based on broad cross-linguistic evidence. In many languages stress placement is sensitive to the sonority of vowels (low, mid, high), but de Lacy wonders why no other property ever seems to play a role.

(4) "One issue this typology raises is not why stress is sensitive to sonority, but rather why it is not sensitive to so many other properties. There are no stress systems in which subsegmental features such as Place of Articulation or backness in vowels plays a role in assigning stress. The same goes for features such as [round], [nasal], and secondary articulation." de Lacy (2002: 93)

3.4. Tone

The situation for tone is much the same as for stress. In many languages contour tones may only appear on heavy syllables, and what counts as heavy is determined by the parametric choices shown under (5). The table summarizes the typological work by Gordon (2006: 34, 85) based on the study of some 400 languages.

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[10] Again (see notes 3, 6, 8) laryngeal properties are irrelevant: there is no case on record where a syllable counts as heavy only, say, when the coda consonant is voiced.

(5)   syllables that can accommodate contour tones (i.e. which count as heavy)

		CV	CVT	CVR	CVV
a.	Somali	–	–	–	yes
b.	Kiowa	–	–	yes	yes
c.	Hausa	–	yes	yes	yes
d.	no restriction	yes	yes	yes	yes

Hence factors that play a role are syllable structure (closed vs. open) and the sonority of coda consonants. Melody as a conditioning factor is unheard of, though: there is no case on record where, say, contour tones can hook on syllables that have a coda, but only if the coda is labial (or only if the coda is voiced: laryngeal properties play no role either).[11]

3.5. Positional strength of post-coda consonants

Consonants may occur in five different positions of the linear string: 1) word-initially #__, 2) after a Coda C.__, 3) intervocalically V__V, 4) before a heterosyllabic consonant __.C and 5) word-finally __#. These exhaust the logically possible positions for consonants (branching onsets, i.e. typically *muta cum liquida*, lain aside). Table (6) shows how the five basic positions lump together in many languages.

(6) the five basic positions and their grouping

	position	usual name
	position	**usual name**
a.	#__V	word-initial
b.	VC.__V	post-coda
c.	V__.CV	internal coda
d.	V__#	final coda
e.	V__V	intervocalic

> strong position

> coda

> weak positions

Positions are arranged according to their effect. The coda disjunction __{#,C} is known since at least the 19ᵗʰ century and was one of the major arguments at the origin of the autosegmental idea, which (re)introduced syllable structure into the hitherto linear SPE model. The exact mirror context, i.e. "after

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[11] Gordon points out an interesting asymmetry between stress and tone regarding the commonness of the patterns "any coda heavy" vs. "only sonorant codas heavy":

   "[o]ne of the more striking distributional asymmetries between different phenomena is one discussed earlier: the difference in weight criteria found in stress systems compared to those found in tone systems. In particular, the CVV(C), CVR heavy criterion is quite common in tonal systems, but extremely rare in stress systems. Conversely, the CVV(C), CVC heavy criterion is vanishingly uncommon for tonal weight, but well attested in stress systems" Gordon (2006: 52).

a heterosyllabic consonant and word-initially" {C,#}__ is called the strong position on account of its effect, which is also opposite in regard of the coda: consonants in this position are shielded against lenition and undergo fortition. The empirical reality of the strong position is also established since the 19th century (for example in the Romanicist literature, Bourciez & Bourciez 1967 [1889]: 122), but less well among phonologists, even in case they specialize in positional strength: the very existence of the post-coda position as a relevant player in lenition and fortition, and hence the strong position disjunction {C,#}__, is outright ignored by Kirchner (1998) and Beckman (1997, 1998).

Segmental strength induced by the position in the linear string (i.e. by syllable structure) is described at greater length in Ségéral and Scheer (2008a). Because of its properties the strong position disjunction is called the Coda Mirror in Ségéral and Scheer (2001, 2008b) where it is reduced to a single and unique phonological object (consonants in the strong position occur after an empty nucleus __ø) that is the mirror image of the coda disjunction (consonants in this position occur before an empty nucleus __ø).

Relevant for the present article is a cross-linguistic parameter that controls the behaviour of consonants in post-coda position. In this context, consonants may either be strong no matter what, or only after obstruents (while following a weak pattern after sonorants). The variation thus depends on the preceding coda: either languages take into account its content, or they do not. In case they do, the effect appears to be cross-linguistically stable: preceding sonorants provoke weakness of the post-coda consonant, while preceding obstruents induce (regular positional) strength. The reverse distribution (i.e. strength after sonorants, weakness after obstruents) does not seem to exist.[12]

The empirical record for the pattern "strong after obstruents, weak after sonorants" is plentiful. A case in point is post-tonic t lenition in various varieties of English, which is sensitive to whether the preceding consonant is a sonorant or an obstruent (Harris and Kaye 1990: 265; Harris 1994: 222ff). While flapping (New York) and glottaling (London) of underlying /t/ are observed in post-tonic position after sonorants (*quarter*, *winter* are pronounced with a flap or a glottal stop, respectively), neither damage occurs after obstruents (*after*, *custard*, *chapter*, *doctor* appear with a [t]).

The weakness of post-sonorant consonants is also observed in Finnish Consonant Gradation. The phenomenon has received quite some attention in the early autosegmental literature (e.g. Campbell 1981; Keyser and Kiparsky 1984); it is described in detail by Pöchtrager (2008). The ground rule is "onsets appear in strong grade in open, in weak grade in closed syllables." Along these (somewhat exotic) lines, a variety of strong and weak incarnations of segments is distributed. Consider for example the alternation between *kulta*,

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[12] Again (see notes 3, 6, 8, 10) laryngeal properties are irrelevant: there is no case on record where a post-coda consonant is strong except if, say, the preceding coda is voiced.

ranta 'gold, beach Nom.sg' and *kulla-n*, *ranna-n* 'id. Gen.sg': the concatena-
tion of the genitive marker, which closes the last syllable, triggers lenition of
the last consonant of the stem, which in case of RT clusters results in the loss
of the obstruent and the expansion of the preceding sonorant. That we face le-
nition may be seen when looking at the spirantising effect of the genitive on
simplex intervocalic stops: *leipä* 'bread Nom.sg' comes out as *leivä-n* 'id. Gen.
sg'. However, post-coda obstruents are shielded against damage if the preced-
ing coda is an obstruent as well: the genitive of *matka* 'journey Nom.sg' is *mat-
ka-n* (not **matta-n*).

The same lenition pattern also produces Grimm's Law, which is usually de-
scribed as a spontaneous sound shift whose relevant part for the present pur-
pose has affected all Indo-European aspirated voiced and plain voiceless stops,
which are spirantised without any contextual condition. Textbooks then men-
tion some "exceptions" (Streitberg 1895: 113 is one example in a long tradi-
tion): stops that occur after obstruents remain undamaged. Compare for ex-
ample Lat. *specio*, *captus*, *nocte* with Old High German *spehōn*, *haft*, *naht* 'to
look out, captivity, night' where p,t,k appear unmodified in the daughter lan-
guage. On the other hand, stops do undergo spirantisation after sonorants:
compare for example Lat. *mentum*, *uerto* with Gothic *munÞs*, *waírÞan* 'mouth,
to become'. The correct description of the environment of Grimm's Law is thus
"everywhere except after obstruents."

Further empirical evidence is discussed in Ségéral and Scheer (2008a:
156–161), including Korean where plain stops lenite after sonorants but
strengthen after obstruents (Kang 1993; Silva 1993).

4. Structuralization of sonority

The first consequence to be drawn from the fact that sonority and melody are
different in kind is the understanding that their traditional representation on
a par cannot be right. In SPE, major class features such as [±son], [±cons]
or [±voc] were scrambled with features defining melodic properties such as
place of articulation and laryngeal properties in a single feature matrix. OT
implements sonority along the same lines, except that scrambling concerns
constraints, rather than features: sonority hierarchies that may involve quite
a number of fine-grained distinctions (Parker's 2011: 1177 scale has 17 steps[13])
are converted into a harmony scale which in turn is translated into constraints,

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[13] Steve Parker's (2008, 2011, 2012, 2017) work on sonority addresses different manifesta-
tions of sonority (phonetic, phonological, cognitive, neurophysiological) in typology and ex-
perimental phonology (Parker 2017: 1), but pays less attention to the question how sonority is
or ought to be represented in phonological theory. In his 2011 overview article for example the
issue is not discussed.

one for each step on the scale. Smith and Moreton (2012) provide an overview of the workings of this approach: the partial scale (high to low sonority) low vowels > mid vowels > high vowels for example becomes *Peak/HighV >> *Peak/MidV >> *Peak/LowV. These constraints are scrambled with all other constraints, including those that refer to melody, in a single constraint hierarchy.

Contrasting with SPE and OT, Feature Geometry made a first step towards the structural representation of sonority. The theory introduced by Clements (1985) autosegmentalized the amorphous bundle of SPE features, aiming at grouping them into natural classes (class nodes) in a feature geometric tree (more on this in section 5.4). In this approach sonority is still represented in terms of the SPE features (or some version thereof), but following the class node logic the features at hand are grouped together and isolated from other classes of features. In Clements and Hume's (1995) final model of Feature Geometry, [±son], [±approximant] and [±vocoid] are borne directly by the root node. This may be interpreted as the recognition of the fact that sonority is different, but it is more a result of the general idea that there are classes of features that are grouped under specific nodes than an attempt to make sonority special.
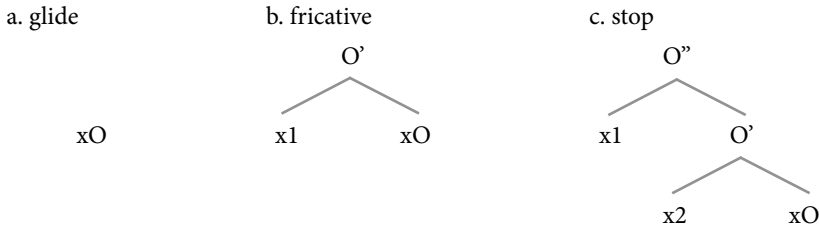
Feature Geometry may thus be seen as a first step in assigning sonority a structural status: its basic carriers are still features, but they occupy a specific structural location in the tree.

Further promoting the structural idea, Standard Government Phonology (SGP) has taken the step to give up on representing sonority with primes. The basic infra-segmental building blocks in SGP are Elements, rather than features (Elements are bigger units than features: |I| for example describes the high front tongue body position, hence is the equivalent of a number of features). But there are no specific Elements describing sonority. Rather, the idea introduced by Harris (1990) is that sonority may be read off segmental structure: the more complex a segment, the less sonorous it is. Complexity is determined by the number of primes (Elements) that a segment is made of. Roughly (and depending on the particular version of Element Theory endorsed, see Backley 2011: 114ff), sonorants are only made of place definers (yod for example is |I| alone), fricatives bear an additional noise element |H|, while stops are also defined by the stop element |ʔ| on top of that.

SGP thus operates a principled divorce between melody (defined by primes) and sonority (defined as a function thereof): the only identity of sonority is structural. Conceiving of sonority in terms of segmental complexity faces some issues, though, namely with vocalic sonority: the least sonorous high vowels [i,u] are made of one Element (|I| or |U|), but so is the most sonorous vowel [a] (|A|), with more complex two-Element mid vowels in between (e = |I,A|, o = |U,A|). Also, the high front rounded vowel [y] identifies as |I,U| and should thus pattern with mid, rather than with high vowels – but that is not the case.

Taking stock of these issues (Pöchtrager 2006: 55ff) and namely of those pertaining to the Element |A|, GP2.0 (Pöchtrager and Kaye 2013) proposes a different way of representing sonority as a structural property of segments. The idea is the same as before (the less sonorous the more structure), but structure now embodies as projections in a hierarchy-expressing tree. As shown under (7) (adapted from Pöchtrager 2006: 61ff and Pöchtrager and Kaye 2013: 57), glides are just an x-slot by itself (O stands for onset), fricatives possess one extra layer (O'), while stops are characterized by two additional layers (O', O").
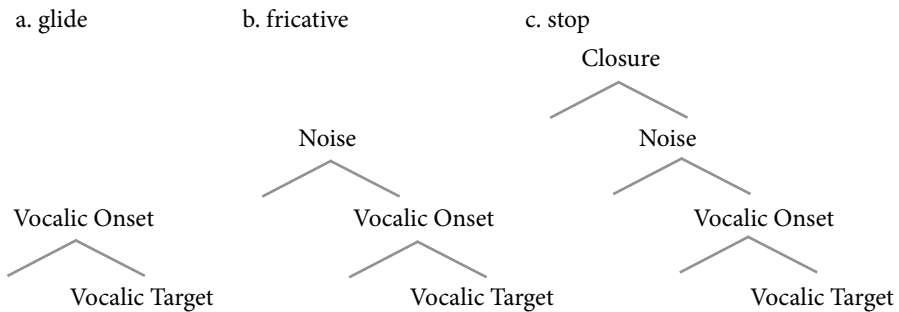
(7)   fricatives vs. stops in GP2.0

a. glide   b. fricative   c. stop

                                        O'   O"

     xO   x1   xO   x1   O'

                                                                                    x2   xO

Additional layers are not the general means of representing sonority in GP2.0, though: while glides and rare bare x-slots (7a), nasals and laterals instantiate the two-layered structure under (7b) (Pöchtrager 2006: 85–91).

Following up on GP2.0, Schwartz' (2012, 2013, 2017) Onset Prominence model takes the arboreal complexity idea to its logical end: all sonorants are treated on a par in a poorly layered structure (melodic primes sit in the Vocalic Onset node), as shown under (8a). Fricatives possess one more layer (Noise) (8b), while stops have two extra layers (Noise and Closure) (8c). Note that an Onset Prominence tree represents a full CV sequence whereby the vocalic part is dominated by the consonantal part (hence the name of the approach).

(8)   sonority in Onset Prominence

a. glide   b. fricative   c. stop

                                                                          Closure

                                     Noise   Noise

Vocalic Onset   Vocalic Onset   Vocalic Onset

     Vocalic Target   Vocalic Target   Vocalic Target

A different take on the structural identity of sonority is developed in the work by Joaquim Brandão de Carvalho (2002, 2008, 2017). The founding idea of this approach is that the red line between structure and primes separates place of

articulation (primes) and all other segmental properties, i.e. manner and laryngeal specifications (structure). Hence sonority (manner) is isolated from one piece of melody (place), but put on a par with another piece of melody (laryngeal properties). As was mentioned in note 1, there are empirical reasons to follow this track (lenition trajectories involving both major class distinctions and laryngeal properties), but the phenomena discussed in sections 2 and 3 firmly exclude laryngeal properties from the segmental characteristics that they work with, i.e. major class distinctions that are called sonority in this article.[14]

Carvalho's view is implemented based on two parallel strict CV tiers, one encoding consonanthood (C-plane), the other representing vowelhood (V-plane), and which are synchronized through a central skeleton of timing units. Consonantal positions on the C-plane are prominent (shown by capitalization under (9): On for Onset + nucleus), while vocalic positions on the V-plane enjoy prominence (oN for onset + Nucleus). Melodic primes (i.e. basically place features, maybe nasality) are associated to the boldfaced positions under (9).[15]

(9)   sonority in Carvalho's contour-based model

	a. vowel	b. sonorant	c. fricative	d. affricate	e. stop
C-plane	O n	**O** n	O **n**	**O** **n**	**O** n
skeleton	x	x	x	x	x
V-plane	o N	o N	o N	o N	o N

The prototypical extremes of the sonority hierarchy are alignments of N and n for vowels, of O and o for stops. That is, in an onset-nucleus sequence a skeletal slot is attached to both N and n (vowels (9a) or both O and o (stops (9e), without any other association. Intermediate major classes bear additional associations that introduce some amount of vowel- or consonanthood: sonorants under (9b) are consonants associated to N (rather than to o), fricatives under (9c) sit on an n that is associated to an o. Finally, affricates under (9d) are like fricatives except that the skeletal slot is also associated to O, thereby establishing the O-x-o association characteristic for stops shown under (9e).

Finally, van der Hulst's (1994, 1995, 1999) Radical CV Phonology also strucutralizes sonority, but pursues a different perspective that recognizes only two basic building blocks (primes), C and V, which represent vowel- and

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[14] The fact that major class distinctions sometimes go along with laryngeal properties (lenition) but at other times are the only relevant segmental characteristic (syllabification, phenomena in section 3) is further discussed in section 5.4.

[15] The segmental identities shown under (9) are adapted from Carvalho (2017: 611) and authorized by the author.

consonanthood. They occur in a feature geometric structure that defines seg-
mental (but also syllabic) properties where each terminal contains one of the
four combinations of C and V: either prime by itself, or a combination there-
of. C and V combine along the Dependency principle that one will dominate
(head) the other (dependent): CV (C over V, the former being the head) or VC
(V being the head). Hence the set {C, CV, VC, V} occurs under the Manner
node as much as under the Place node. In the former V is interpreted as a vow-
el, VC as a sonorant, VC as a fricative and C as a stop. When dominated by the
Place node, V produces lowness (equivalent to |A| in Element Theory), VC is
responsible for highness, CV for labiality (Element |U|) and C for coronality
(Element |I|) (Hulst 1999: 97, 101). Hence C and V are not entirely devoid of
(phonetic) substance since they are not interchangeable (V couldn't represent
consonants, or C vowels), but they are multifunctional: they express sonority
as much as place.

    Like in the other approaches discussed where sonority is structuralized,
there are no specific primes for sonority in Radical CV Phonology. But sonor-
ity is not structure alone (as in the other models): it needs primes in order to
be expressed, be they multifunctional.

5. Two phonologies: sonority lives in a different module

5.1. The goal is not the structuralization of sonority, but its segregation from melody

Sections 2 and 3 have adduced evidence to the end that sonority is segregat-
ed from melody. The question is how exactly this segregation should be ex-
pressed. An obvious conclusion is that scrambling sonority and melody in the
same computational or representational device cannot be right. Indeed, the
exclusive reference to sonority with melody being irrelevant and invisible for
the processes discussed in section 3 comes as a surprise if sonority and melody
cohabitate in the same space: we know that this space is accessible for the pro-
cesses at hand, and there is no reason why they should selectively take some
items into account, while others are actively ignored.

    SPE and OT are thus misled in their way of treating sonority. Even though
Feature Geometry isolates sonority from melody by a structural means (more
on this in section 5.4), it also counts in this category since like in SPE and OT
the basic carriers of sonority and melody belong to the same ontological cat-
egory, features. This is also the case of Radical CV Phonology which has the
same feature geometrical segregation of sonority and melody that dominates
primes, C and V. But since C and V (and combinations thereof) are the only

primes that occur under all branches of the tree, sonority and melody are even more scrambled than in Feature Geometry where primes expressing sonority and melody are distinct.

The other approaches discussed fall into two types according to their agenda: either the structuralization of what is traditionally considered as features specifically concerns sonority, or other segmental properties on top of sonority are also made structural. Harris' complexity in SGP and Schwartz' Onset Prominence fall into the former category, while GP2.0 and Carvalho's contour-based approach instantiate the latter type. The explicit goal of GP2.0 is indeed to reduce the number of primes (Elements), and this also – and in actual fact prominently – concerns the Element |A|, for which a structural identity is sought. Carvalho's approach segregates place (primes) and sonority (structure), but in his system laryngeal properties side with the latter. While this may reflect the workings of some other phonological phenomena, it does not correspond to the division warranted by the evidence discussed in sections 2 and 3.

What sections 2 and 3 show is that sonority (major class distinctions) and melody (place and laryngeal properties) are ontologically distinct and need to be separated. Hence scrambling them in the same structure is not any better than mixing them in the traditional feature set. In GP2.0 the structuralization of sonority is a mere by-product of the actual agenda, i.e. a more general strive towards structuralization that roots in a reaction against the overgeneration produced by primes and their combination. Unlike in Carvalho's system where the red line runs between sonority and laryngeal properties on the one hand and place on the other, the structuralized items in GP2.0 are a mixed bag: sonority, laryngeal properties plus the Element A.

From a modular point of view the reduction of either structure to primes (SPE) or primes to structure (tendency of GP2.0) makes no sense: modules carry out a computation that takes (domain-)specific primes as an input and returns structure (in syntax: number, person, gender, animacy etc. are transformed into a syntactic tree). That is, structure is the output of a computation whose input are primes that belong to a domain-specific vocabulary.[16] Hence both primes and structure must exist.

Another aspect of the dualist nature of modularity is the necessity of both structure and computation. SPE and OT are systems where structure has no say and decisions are only made by computation (whether this evolution is

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[16] The workings of modularity (Fodor 1983) are explained in Segal (1996), Gerrans (2002) or Coltheart (1999), its application to linguistics since Chomsky (1965: 15ff) in Scheer (2011: §622). A central consequence of modularity is domain specificity, i.e. the fact that different computational systems work on distinct, proprietary vocabularies. This is the raison d'être of interfaces: different vocabularies are mutually unintelligible (items such as number, person, gender etc. that are used in morpho-syntactic computation, as opposed to labial, occlusion, voice etc. that are the input to phonological computation). Hence communication among computational systems requires translation.

by a computational tropism or on the grounds of a purposeful agenda as expressed by de Lacy 2007). Over the years a number of voices have explained that phonology cannot reduce to just a theory of computation: it is necessarily made of both a theory of representations and a theory of computation (Scheer 2010). In this sense OT is not a theory of phonology for which it is often mistaken, but rather a theory of computation (as originally defined by Prince and Smolensky 1993 [2004]). The historical view on the phonology in the 20th century by Anderson (1985) is all about the see-saw movement between representationally and computationally oriented theories. The author concludes that the reduction of phonology to either must be wrong and – writing in 1985 at the peak of representationally oriented autosegmentalism – correctly predicted that a new wave of computationalism would be rolling over phonology. OT was not even in the making then.

5.2. Representations don't fall from heaven

For the present purpose it is useful to bear in mind that all approaches discussed in section 4 which in one way or another promote the structuralization of sonority are representationally oriented. The geometry introduced by Feature Geometry participates in the complementation of purely computational SPE with autosegmental structure. Government Phonology in general and all its implementations (Standard GP, Strict CV, GP2.0, Onset Prominence and also Carvalho's approach, which explicitly leans on Strict CV) are strongly representational in kind. That is, there is no real theory of computation to speak of in Government Phonology (see Scheer 2011b: 425f).

This may be the reason why a central question that arises when representations are focussed on never appears in the discussion: how do these representations come into being? The phonetic signal that reaches the human cognitive system does not contain any.[17] Upon L1 acquisition as much as during adult life new words are integrated into the lexicon and manipulated by the linguistic system. Hence there must be some computation that successively transforms the phonetic signal into whatever phonological representations are supposed to exist. A key question in this process is what exactly is stored in the lexicon. The traditional assumption is that the units stored are segments – unsyllabified segments. That is, some computation has already purged the signal from linguistically irrelevant information (emotional state, eventual drug influence, male / female voice etc.) and identified minimal units that are relevant in temporal succession and for the purpose of contrast, i.e. segments

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[17] Of course the phonetic signal contains all kinds of information that is used for building structure, but not the structure itself. Representations are the result of a cognitive computation based on the phonetic signal and other, signal-independent properties of the computational mechanism such as language-specific parameters regarding syllable structure (such as the presence of codas or branching onsets in a given language).

(or phonemes). When phonology is running in online derivation, then, segments are retrieved from the lexicon and parsed by phonological computation which is responsible for both melodic processes (e.g. palatalization) and the construction of syllable structure. Here as well, both types of computation lie in the same computational system (rule set traditionally, constraint ranking in OT). But in any case there is a specific type of computation establishing syllable structure: the syllabification algorithm.

Government Phonology has a slightly different take on this overall architecture since in this theory syllable structure is held to be present in the lexicon. It is sometimes concluded that there is no syllabification algorithm in Government Phonology since none is needed in online computation which is fed by fully syllabified morphemes, but this of course is a mirage (sometimes fuelled by the GP literature). If syllable structure is present in the lexicon it must have gotten there somehow. Hence GP simply divorces phonological computation into two distinct systems that operate in different locations and at different stages: syllabification is carried out upon lexicalization, while melodic computation occurs later on when lexical items are loaded into working memory in order to participate in a phonological derivation (Scheer 2012a: §138 note 24; Faust et al. 2018).

It thus appears that any representational segregation of sonority and melody is necessarily the result of a computational segregation: representations are not present in the phonetic signal or fall from heaven. In other words, anybody who wants to segregate sonority and melody in representations is in fact talking of distinct computational systems. As far as I can see the approaches discussed in section 4 are mute regarding the question of how their representations come into being.

The situation is thus unambiguous in a modular perspective: if sonority and melody need to be segregated, there are two distinct computational systems that construct them. This means that there are two distinct vocabularies that form the input to each module, one representing sonority, the other melody. They are mutually unintelligible, which is the reason why melody is absent from syllable structure (section 2) and invisible for higher processes (section 3).

5.3. Segment specificity

If sonority and melody are segregated in two distinct computational systems, the obvious fact that they both co-define individual segments begs the question. That is, it must somehow be guaranteed that any given segment enjoys its individual lexical specification for sonority and melody, even though these do not cohabitate.

This situation is known from the morpho-syntax – phonology interface where idiosyncratic properties of single lexical entries (morphemes) are used

by multiple computational systems. The lexical entry of a morpheme stores three types of information written in three distinct vocabularies that are accessed by three different computational systems: morpho-syntax (using vocabulary items such as number, person, gender etc.), semantics (LF-relevant properties) and phonology (vocabulary items such as occlusion, labiality, voicing etc.). The lexical entry for *cat* for example may look like this: [<morph-synt. = animate, count etc.>, <sem. = "idea of cat">, <phon. = /kæt/>]$_{\text{MORPHEME}}$.

In the same way, the lexical identity of a segment contains two compartments that host items from two distinct vocabularies: [<sonority>, <melody>] SEGMENT. Each vocabulary is then accessed by relevant computational systems. For instance, the computation that builds syllable structure is specific to <sonority> and can only parse this vocabulary. Hence only <sonority> is projected and the result of the computation contains no other information. This is why other computations, occurring above the skeleton and taking into account items in that area (those discussed in section 3) are unable to access anything else than sonority. On the other hand, melodic computation (e.g. palatalization) accesses only <melody> (and outputs also <melody>).

5.4. Feature Geometry, but with domain-specific terminals

It was mentioned in note 1 that regular sonority scales include both <sonority> (in the sense used in this article, i.e. restricted to major class distinctions) and laryngeal properties, which according to the diagnostics of section 2 and 3 are a piece of <melody>. This indicates that the computation(s) that is (are) at the origin of these sonority scales (such as lenition) use(s) both <sonority> and a piece of <melody>, laryngeal properties. This means that the content of <melody> may be selectively accessed, which suggests that this category actually falls into two distinct vocabularies, <place> and <laryngeal properties>. The fact that there is a computation that specifically uses laryngeal properties and no others (voice assimilation etc.) supports this conclusion. The segment may thus be made of three compartments: [<sonority>, <place>, <laryngeal properties>]. How exactly the internal structure of the segment looks like is a question that goes too far afield in the frame of the present article, but as may be seen it amounts more or less to the natural classes (or phonologically active classes in Mielke's 2008 terms) that Feature Geometry has tried to isolate in the branches of the geometric structure.

Hence the lexical divisions of the segment follow the feature geometric idea that different classes of primes are segregated (under different branches of the tree). What is added to this lexical structure of the segment is the domain-specificity of terminals, i.e. the primes (features) dominated by class nodes in a regular feature geometric tree. These are not just different instantiations of the same type of items (features, Elements), but belong to ontologically distinct vocabularies that a number of different computational systems (which taken together we call phonology) may or may not be able to read: computation is

domain specific (see note 16). Or, in other words, every class node in a feature geometric tree (representing natural, or phonologically active classes) defines a domain-specific vocabulary.

A number of different computational systems, each being defined for taking into account certain types of vocabulary, then access the lexically defined information that segments provide: syllable structure is built by a computation that can only read <sonority>, lenition is a computation that works with <sonority> and <laryngeal specifications> (but not with <place>), palatalization only computes <place> and so forth.

5.5. Syllable structure sensitivity

Finally, another condition needs to be met when sonority / syllable structure and melody are segregated: syllable structure sensitivity. Of course melodic computation is sensitive to syllable structure, which is an efflux of sonority. Trivially, say, l-vocalization occurs in coda position and vowel harmony is a relationship between nuclei. If syllable structure is a function of sonority (and linearity) but sonority and melody are incommunicado, how come melodic computation has access to sonority-generated information? The answer to this question is that it is not sonority itself that melodic computation appeals to, but the output of the sonority-based computation, i.e. syllable structure. The linear string of phonologically relevant items is made of segments, and (as explained in sections 5.3 and 5.4) segments are single lexical entries that decompose into thee compartments <sonority>, <place>, <laryngeal properties> (in the same way as morphemes are single lexical entries that have three distinct compartments hosting syntactic, phonological and semantic information). When the sonority-based computation builds syllable structure, the result, syllabic positions, are affiliated not just to the sonority values that they originate in, but to segments as such: only wholesale segments have syllabic affiliation.

This again is parallel to the upper interface of phonology where only the information contained in the morpho-syntactic compartment of the morpheme is used in order to carry out vocabulary insertion (the matching of portions of the morpho-syntactic tree that was built by morpho-syntactic computation with the morpho-syntactic properties of candidate morphemes).[18] As a result

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[18] This scenario follows Late Insertion (introduced by Distributed Morphology, DM, Marantz 1997) where the input to a numeration are bundles of morpho-syntactic features picked from a separate morpho-syntactic lexicon. This is different from the traditional take (including the Government and Binding framework of the 1980s), where the input to syntactic computation were fully-fledged morphemes of which only the morpho-syntactic compartment was used in order to build the morpho-syntactic tree (the rest being present but unused, carried over to phonology in "sealed suitcases"). While DM does away with sealed suitcases by introducing Late Insertion, the input to syntactic computation are still bundles of features (corresponding roughly to morphemes). Nanosyntax goes one step further by claiming that it is individual features which are the input to syntactic computation (Starke 2009: 1, 2013, Caha 2009: 25). But all approaches

of this operation, though, the whole morpheme is affiliated to the portion of the syntactic tree, not just its morpho-syntactic compartment: the content of its phonological compartment is inserted as the input to phonology.

On the segmental side, once syllable structure is built the whole segment is thus affiliated to a given syllabic position. It is this affiliation which is visible upon melodic computation, because melodic items are located in the segment. The syllabic affiliation of the sonority compartment of a segment is thus legitimate in the modular sense (it represents a relation between the input and the output of a modular computation), and is transmitted to the melodic compartment of the segment because the segment as a whole bears the affiliation.

As was shown in sections 2 and 3, melody-free syntax describes the observation that melody does not impact morpho-syntactic computation. There is no sonority-free phonology, though, because sonority and melody cohabitate in the same single lexical entry, the segment, whose sonority-based affiliation extends to all of its compartments. This basic asymmetry obtains because there is a structure-building computation based on sonority, but not on melody.

Space limitations preclude going further into these matters, to be considered greater in depth elsewhere.

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to the upper interface quoted share the idea that lexical entries representing morphemes (which are accessed upon vocabulary insertion in DM and nanosyntax) are compartmented, whereby compartmented information is used selectively in order to carry out computation.

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