Voicing is Not Relevant for Sonority

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0. Ranking segments with respect to sonority is clearly needed for syllabification (Jespersen 1904, Hooper 1976, Venneman 1984, Steriade 1982, Clements 1987), and a typical hierarchy has been (1) vowels > glides > liquids > nasals > obstruents.

In addition to the features that would characterize the above segments, it has often been proposed that voicing and continuancy also play a role in the hierarchy. (2) gives Jespersen's version of the sonority scale, in which both voicing and continuancy are relevant in defining sonority.

(2) Jespersen's (1904) sonority scale
    voiceless stops/voiceless fricatives
    voiced stops
    voiced fricatives
    nasals/laterals
    voiced r-sounds

I will argue in this paper that continuancy, but not voice, can be relevant on a language-particular basis for computing sonority. Although it is not relevant here to discuss whether the universal sonority ranking should be derived from the major class features or assumed to be a primitive entity in the grammar, I will follow Clements (1987) and Zec (1988) in assuming that the sonority scale should be defined in terms of independently motivated binary features.

1. Whereas it has been agreed that the sonority scale given in (1) is valid universally, there have been several approaches with respect to the two features [continuant] and [voice], as summerized in (3).

(3) place for [voice] and [continuant] in sonority
   a. voiced obstruents > voiceless obstruents (Basboll 1974)
   b. fricatives > stops (Zec 1988)
   c. either a or b on a language-particular basis (Steriade 1982, Selkirk 1984, Levin 1985, Clements 1987)

Basbøll (1974, 1988), for instance, argues that voicing is part of the universal hierarchy but the distinction between fricatives and stops is not, mainly on the basis of the fact that /s/ can occur at the margin of the syllable, separated from the nucleus by a stop whereas a voiced obstruent cannot occur outside of a voiceless obstruent. His analysis is based on Danish, in which voiceless stops occur outside of voiced fricatives, as illustrated by the data in (4). In addition, /s/ + stop clusters such as /sk/ and /st/ are allowed, as is the case in many other Indo-European languages.

(4) Danish (Basbøll 1974)
    skvulp, tvoerg, skoelmsk

Given the analysis of /s/ as a heterosyllabic (or extrasyllabic) segment, which is well motivated in such languages as Sanskrit, Latin and Greek (Steriade 1982), there is no reason to assume that voicing is relevant for sonority in Danish. Quite the contrary, such coda clusters as /–lmsk/ (which is listed in (4a)) illustrate that the continuant /s/ should be found closer to the nucleus than the non-continuant /k/, thus arguing for the relevance of the feature [continuant]. An additional argument for excluding the feature [voice] from the sonority scale is based on the commonly-held observation that voicing cannot be interrupted within the syllable. In the next section, I will argue that the voicing constraint within the syllable is due to a universal rule which is independent of syllabification.

On the other hand, Zec (1988) proposes a constrained theory of sonority in which only the features Consonantal, Sonorant, and Approximant are needed universally for sonority distinctions. In addition to the universally needed features, the only relevant features are the so-called stricture features such as Continuant and Glottalized, which can be selected on a language-particular basis. She excludes [voice] from the set of sonority features mainly on the grounds that the use of both of the features [continuant] and [voice] creates inter-language conflicts in sonority ranking, resulting in a situation (as shown in (5)) in which /s, z/ are more sonorous than /t, d/ in one language while /d, z/ are more sonorous than /t, s/ in another language.

(5) Sonority Conflicts (Zec 1988)
    Language A (the feature [continuant] is chosen for sonority)
    t, d are less sonorous than *s, z.*
    Language B (the feature [voice] is chosen for sonority)
    t, s are less sonorous than *d, z.*

She argues that language-specific modifications cannot create a situation in which one segment, *a*, is more sonorous than the other segment, *b*, in one language and *b* is more sonorous than *a* in another language. In order to have language-specific modifications constrained properly and not to allow such conflicts, Zec eliminates [voice] from the sonority scale.

Yet another approach is represented by Steriade (1982), Selkirk (1984) and Levin (1985), who take the position that either of the features can be chosen on a language-particular basis. Similarly, Clements (1987) assumes that languages may include the features [continuant] and/or [voice] in their definition of the sonority scale as a marked option.

This paper presents several arguments for the position taken by Zec that [voice] is not part of the sonority hierarchy in any language. I will examine all the putative cases known to me in which [voice] plays a role in the sonority scale, and conclude that these cases should be reanalyzed either as involving Universal Devoicing or as illustrating OCP-based negative constraints.

3. The main justification for including [voice] has been the fact that in some languages voiced obstruents are located closer to the syllable nucleus than voiceless obstruents (Greenberg 1978). Thus voiced obstruents would rank higher in sonority than voiceless obstruents. This line of argument suffers from the misconception that all the sequencing constraints within the syllable can be characterized by sonority. However, it has been observed by many (Kiparsky 1979, Clements and Keyser 1983, Clements 1987, Zec 1988) that not all sequencing constraints in syllabification are due to sonority. Syllabification is governed not only by sonority but also by various other constraints. I propose that the constraint governing the position of voicing within the syllable is not due to sonority but to a universal rule of devoicing.

Greenberg, after investigating 104 languages, arrives at the conclusion that voicing agreement in syllable internal obstruent clusters is a strong tendency but there are exceptions. The exceptions are of the type in which voicing is found closer to the nucleus.[1] For example, there are a few languages which allow an initial unvoiced + voiced sequence and a final voiced + unvoiced sequence, as shown in (6).

(6) Examples of tautosyllabic Voicing disagreement
English (svelte, midst), Swedish (to:gs)
Coeur d'alene (/tg^w-/, /stg^w-/), (/-g^{w}t/, /-g^{w}ts/)
Palaychi Karen (/sz-/, /fv-/, /kj-/)
Gilyak (/-vf/)

The clusters shown in (6) are well-formed since the consonant with the feature [voice] is found closer to the nucleus than that without the [voice] specification.

In an earlier paper (Cho 1990a), I proposed the Universal Tautosyllabic Voicing Constraint which is based on the observations of Greenberg (1978) and Harms (1973) that in cases of voicing disagreement voiced obstruents are always located closer to the syllable nucleus than voiceless obstruents (which I call Universal Tautosyllabic Voicing Constraint (UTVC).

Universal Devoicing is formulated in (7).

(7) Universal Devoicing

```
 σ[C         C
   ǂ       [-son]
 [voice]
---------------------->
    syllable nucleus
```

In this account, the reason why some languages allow onset clusters of the form "[–voice] [+voice]" but not of the form "[+voice] [–voice]" is not that voiced consonants are more sonorous than voiceless consonants, but that the latter structure is ill-formed universally.

I will very briefly illustrate how Universal Devoicing works by using the data in English and Swedish.

(8) English Voicing Assimilation (Halle and Mohanan 1985, Mascaró 1987)

a. Level 1 Voicing Alternation

leave–left	five–fifth–fifty
lose-lost-loss	life–lives–lively
cloth-clothes-clothing	

dialectal variations: *width, breadth, hundredth*

b. Tautosyllabic clusters that do not agree in voicing: *svelte, midst*

c. Voicing Alternation in Inflection

fans [z]	laps [s]
Jay's [z]	Dick's [s]
he's [z]	that's [s]
tied [d]	kissed [t]
phoned [d]	talked [t]

d. Post-lexical Voicing Alternation
Bob's [z] a fool/ Pat's [s] a fool.

First, there is a devoicing effect in level 1 as shown in (8a); for some forms devoicing is obligatory (*fifth*) while other forms exhibit dialectal variations (*width*). Following Mascaró, I will assume that the voicing agreement in level 1 between the stem-final consonant and the voiceless suffix is essentially different from that of the regular inflection and postlexical voicing. For one thing, while some suffixes obligatorily trigger voicing agreement (*fifth, left, cleft, lost*), others do so only in certain dialects (Kenyon and Knott 1953, Hayes 1986) as shown in such forms as *width, breadth, hundredth.* If the voicing agreement were accomplished by a language-specific rule that ensures voicing agreement in tautosyllabic clusters, as has been formulated by Halle and Mohanan (1985), these forms, together with the words in (8b) would remain exceptions to the rule. In *fifth*, the underlying *v* gets devoiced when the suffix *-th* is attached, whereas the *d* in the *hundredth* is not affected by the rule.

Assuming that the level 1 devoicing is a morphologically governed devoicing rather than triggered by voicelessness assimilation, I have also accounted for the cases in (8c,d) not by assimilation but by devoicing; this time, not morphologically governed but governed by a Universal Delinking rule. Among several ways of handling the dependence of the voicing of the suffixal obstruent on the voicing of the preceding segment, I have assumed that the suffixal consonant has an underlying voice specification and the specification is delinked due to a universal rule. When a voiced suffix is added to a stem that ends in a voiceless consonant, the sequence (e.g. *that-z, lap-z*) creates a violation of the Universal Tautosyllabic Voicing Constraint. UTVC will not affect such English clusters as *svelte, midst, width* but it will apply to the English inflectional endings. Voicing reversals in final obstruent clusters in such words as /lap+z/, /kis+d/ and /pat+z/ are not permitted by the UTVC and the [voice] specification has to be delinked from the suffix.

Swedish can be analyzed in the same way as English.

(10) Swedish Devoicing (Lyttkens and Wulff 1885, Hellberg 1974)

a. Level 1 Devoicing

ha:v 'sea' -s 'adverbial suffix' [hafs]
ti:d 'time' -s [tits]
hö:g + ti:d → [höktid] 'festival'
da:g + s + ljus → [daksljus] 'daylight'

b. Later level

ha:v + s (Gen.) → [ha:v̥s]
to:g + s (Passive) → [to:g̥s]

It should be noted that voicing (and tensing) agreement is obligatory only in morphologically governed contexts as shown in (10a) (before the adverbial suffix /-s/, in established compounds as well as before the nominalizer /-sel/). For instance, the adverbial suffix /-s/ triggers devoicing whereas the genitive /-s/ does not trigger full devoicing. Later devoicing in clusters is not categorical in nature and is a purely phonetic effect. The Universal Delinking triggered by the UTVC does not play a role in the above data since the output of the later level morphology conforms to the UTVC as shown in examples like *ha:v̥s, to:gs.*

Just as in English, a different pattern emerges when a voiced suffix is added to a stem.[2]

(11) Affixation of voiced suffixes

köp + d → köpt 'buy' (past participle)
köp + t → köpt 'buy' (supine)

bygg + d → byggd 'build' (past participle)
bygg + t → bygg̥t 'build' (supine)

In the first example in (11), the voiced suffix /-d/ (past participle) does not survive the UTVC since it is preceded by a voiceless consonant which is closer to the syllable nucleus. On the other hand, when it is preceded by a voiced consonant, there is no reason why it should be delinked. This is in direct constrast to the behavior of the voiceless suffix /-t/ (supine) which triggers only partial (i.e. phonetic) devoicing like other voiceless suffixes.

Traditional accounts have proposed a mirror-image rule that assimilates a voiced obstruent to a voiceless obstruent without regard to the temporal order, much like Halle and Mohanan's (1985) account for English. These accounts find it extremely difficult to explain the different behavior of devoicing effects; categorical in the earlier level and gradient in the later level. In contrast, the present analysis of Swedish devoicing based on Universal Delinking provides a natural explanation for the asymmetrical behavior of voiced and voiceless suffixes.

At this point, it should be noted that there is a crucial difference between Universal Devoicing which governs the tautosyllabic obstruent clusters, and the sonority scale, which also governs sequencing of consonants within a syllable. Several arguments can be put forward for the independence of UTVC from sonority. First, violations of UTVC are always repaired by delinking [+voice] rather than by the usual mechanisms for dealing with unsyllabifiable segments, such as epenthesis or cluster simplification. This clearly shows that the constraint on the sequential ordering of voice within the syllable is independent of sonority. Also, there seem to be no rules delinking features when sonority violations are involved; i.e., there seem to be no rules that change stops into fricatives, fricatives into nasals, etc. when syllabification fails.[3] On the other hand, violations of the Tautosyllabic Voicing Constraint do not result in stray consonants. Rather, sequences of voiced and voiceless clusters in the onset have to be syllabified first in order to undergo devoicing, whereas a consonant left stray after syllabification is subject to epenthesis or deletion.[4] If [voice] is one of the features defining sonority in a language, a voiced obstruent located outside of a voiceless obstruent should remain unsyllabifiable and it should be able to undergo epenthesis or stray erasure.

4. Facts of minimal distance have also been used as an additional argument for including [voice] for computing sonority (Hooper 1976, Selkirk 1984, Steriade 1982, Clements 1987). Often, it has been tacitly assumed that all tautosyllabic clusters should be characterized in terms of sonority ranking; the reason why *blick* is well-formed but *bnick* is not has been attributed to the fact that /b/ and /n/ are not distant enough in a finer-grained sonority scale. Following proposals by Kiparsky (1979) and Zec (1988), I will present

an OCP-based account of minimal dissimilarity, which is independent of sonority sequencing. For instance, the *bnick/blick* fact is better accounted for by a constraint on stop sequences, as shown in (12).

(12) *bnick blick

$* [_{\sigma}$ [–cont][–cont] (Kiparsky 1979)

It is noted by many linguists (Harris 1983, Clements and Keyser 1983) that negative syllable structure conditions (or filters) are necessary independently of sonority. This can be best illustrated by Spanish, as discussed by Harris. In some dialects of Spanish, [tl, tr, dr] are permissible onsets, but not [dl], as shown in (13a). Harris proposes the filters in (13b).

(13) a. Spanish Onsets (Harris 1983)

pr	tr	*čr
pl	(tl)	*čl
br	dr	*sr
bl	*dl	*sl
fr		
fl		

b. Negative filters

tr/dr/tl/*dl

$$* \left[_{\sigma} \begin{bmatrix}\text{+cor}\\ \text{-cont}\\ \text{+voice}\end{bmatrix} \begin{bmatrix}\text{+cor}\\ \text{-cont}\\ \text{+voice}\end{bmatrix}\right.$$

tr/dr/*tl/*dl

$$* \left[_{\sigma} \begin{bmatrix}\text{+cor}\\ \text{-cont}\end{bmatrix} \begin{bmatrix}\text{+cor}\\ \text{-cont}\end{bmatrix}\right.$$

tr/*čr/*sr

$$* \left[_{\sigma} [\text{+alveolar}]\ [\text{+alveolar}]\right.$$

The ill-formed sequences in the third column have been attributed to the negative condition on the sequences of homorganic consonants; i.e., /t/ and /d/ are dentals whereas /r, l, s, č/ are alveolars. Only those clusters whose members differ in place are permissible, as the filter indicates. The use of filters as dissimilarity requirements is needed in many languages which do not allow sequences like [pf], [yi], [wu], [pw], or [tl]. (14) gives some examples of language particular OCP conditions.

(14) Language-Particular OCP Conditions on Tautosyllabic Sequences

a.	*	[+labial]	[+labial]	(English *pw, *bw, *fw)
b.	*	[+round]	[+round]	(Korean *wo, *wu)
c.	*	[–back]	[–back]	(Ignaciano Moxo *yi)

Constraints on tautosyllabic sequences of 'similar' segments can be derived in a principled manner by fine-tuning the Obligatory Contour Principle (McCarthy 1986). According to the present account, any feature including the place features and [voice] can be selected to form language-specific syllable structure constraints.

The fact that negative filters are independent of sonority is illustrated in English where /sl/ is a possible onset whereas /sr/ is not, which should be stipulated as a language-particular idiosyncrasy. An account utilizing minimal sonority distance will fail because the distance between /s/ and /r/ is greater than that between /s/ and /l/, thus falsely predicting that /sr/ is the preferred onset.

Following the arguments proposed by Clements and Zec against Steriade's (1982) 'increasing sonority' constraint that requires some language-specific magnitude of difference between successive segments in onsets, I take (15) to be the universally valid sonority hierarchy, in which neither place features nor voicing play any role.

(15) Universally Valid Sonority Hierarchy (Clements 1987, Zec 1988)
Stops < (Fricatives) < Nasals < Laterals

Steriade (1982) includes the feature Voicing in the sonority scale of Greek, and the feature Coronal in that of Latin. Eliminating these features from sonority is well-motivated; various sonority scales proposed in the literature (Steriade 1982, Selkirk 1984, Levin 1985) are not restrictive enough to allow many instances of inter-language conflict, and involve too many redundancies. In addition, even with language-specific sonority scales and intervals, it is not possible to get rid of idiosyncratic negative conditions.

Sterade propsed the sonority scale in (16) for Greek.

(16) Greek Sonority Scale (Steriade 1982)
[–son, –cont, –voice]: p, t, k
[–son, –cont, +voice]: b, d, g
[–son, +cont, –voice]: s
[–son, +cont, +voice]: z
[+son, –cont, +nas]: m, n
[+son, –cont, –nas, +lat]: l
[+son, –cont, –nas, –lat]: r

The minimum sonority difference for Greek is 4 intervals.

The above scale together with the minimum distance of 4 intervals was proposed to account for the purported fact that voiced stops are more sonorous than voiceless stops, thus allowing sequences of voiced stop + liquid but not voiced stop + nasal, as shown in (17).[5]

(17) Greek Onsets according to Steriade
pn, tn, kn, pl, tl, kl, pr, tr, kr
bl, gl, br, dr, gr <u>but</u> *gn

However, a closer inspection of the data reveals otherwise. First, according to Steriade, the clusters subject to Attic Shortening (*correptio Attica*), leave the preceding syllable as a light syllable whereas all other consonant clusters turn a preceding short vowel into a metrically heavy syllable. Failure of Attic Shortening, then, is an indication that the cluster in question is heterosyllabic. The tautosyllabic assignment of intervocalic clusters is obligatory only in clusters consisting of a voiceless stop followed by a sonorant, or a voiced stop followed by /r/, as shown by (18). Crucially, however, /gl/, which is a well-formed onset according to the scale in (16), patterns with such heterosyllabic clusters as /sk/ and /sp/.

(18) a. Obligatory Attic Shortening (Allen 1973, Steriade 1982)
kr, gr, kl, kn, km, pr, pl, tr, dr, tl, tn
b. Failure of Attic Shortening
gl, gm, pt, ks, sk, spl

The perfect reduplication again manifests the same patterning; i.e., only voiceless stop + sonorant and voiced stop + r clusters are treated as tautosyllabic. As listed in (19), the initial stops in /bl/ and /gl/ fail to be reduplicated in the same manner as /sp, pt, kt/ and /gn/.

(19) a. Perfect Reduplication

krag	ke-kraga 'to cry'
tlā	te-tlamai 'to hit'
pneu	pe-pneuka 'to breathe'
drā	de-drāka 'to pull'

b. Heterosyllabic clusters

sper	e-spermai 'to sow'
ptai	e-ptaika 'to stumble'
gnō	e-gnōka 'to know'
gluph	e-glupha 'to sculpt'

There is a clear distinction between voiceless and voiced stops in Greek in their ability to form onset clusters, but the distinction is not one that can be characterized by manipulating the sonority scale in (16) in any way, since the minimum sonority difference of 4 intervals guarantees both voiceless stop + /l/ and voiced stop + /l/ to be well-formed onset clusters. There is no reason why there is a difference between /gl/ and /bl/ on the one hand and /gr, dr/ and /br/ on the other. Instead, I propose the syllable template in (20a) and the negative condition in (20b) in order to syllabify /gn/ and /gl/ as heterosyllabic but /gr/ as tautosyllabic.

(20) a. Greek Syllable Template
$_{\sigma}$[[−son, −cont] [+son]

b. Negative condition

$$*\left[\begin{bmatrix}+\text{voice}\\-\text{cont}\end{bmatrix}\begin{bmatrix}+\text{voice}\\-\text{cont}\end{bmatrix}\right]_{\sigma}$$

The negative condition in (20b) is based on the OCP-based dissimilarity requirement as in the Spanish filters. While it is clear that nasals are characterized as [–continuant], we need independent evidence that /l/ is [–continuant] (SPE and Tatò (1981)). For instance, as shown by the examples in (21), in nearly all dialects of Spanish the labial and velar voiced obstruents appear as continuant [b] and [g] after [l] whereas the dental stop is realized as the stop [d] in the same environment. Mascaró (1982) accounted for this by assigning either [+continuant] or [–continuant] to [l], depending on the place of articulation of the following segment. In other words, [l] counts as [+continuant] before labials and velars but as [–continuant] before dentals.

(21) Spanish Spirantization (Mascaró 1982)
ca[lƀ]o, ga[lǥ]o, but ca[ld]o

If we allow the continuancy specification of the lateral to vary between languages (or even within the same language) or if we follow Mohanan's (1989) proposal for an additional feature [stop], the negative condition in (20b) might not be as ad-hoc as it first appears. Whatever the right formulation of the Greek constraints might be, it is clear that the feature Voice cannot be employed to account for sonority sequencing.

5. In conclusion, the fact that [voice] is sometimes needed to account for syllable structure constraints does not stem from sonority considerations but from two independent factors; one, Universal Tautosyllabic Devoicing and the other, OCP-based dissimilarity requirements, for which voicing is in no special relation with the features defining sonority.

Notes

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[1] 10 percent of the initial systems contain unvoiced + voiced sequences, and 7 percent of the final systems contain voiced + unvoiced sequences. On the other hand, there is less than 1 percent initial voiced + unvoiced (mostly nasal+ voiceless obstruent) and around 2 percent of final unvoiced + voiced (mostly obstruent + nasal). It can be shown that there is no single case that violates this generalization.

[2] Unlike English, there is some evidence for assuming some suffixes to be underlyingly voiced. When a vowel intervenes between the stem-final consonant and a suffix, some suffixes surface as voiced (as in *kalla* + *d* → *kallad*

'call (Past Participle)') and other suffixes surface as voiceless (as in *kalla* + *t* → *kallat* 'call (Supine)').

[3] In Cho (1990b), I argued against Hankamer and Aissen's (1974) analysis of assimilation in Pali as sonority-driven consonant assimilation, and proposed a reanalysis based on syllable-conditioned gemination. Even the Pali consonantal alternation does not constitute support for feature-changing operations involving syllabification based on sonority.

[4] Adjunction to the edges seems to be an additional mechanism for unsyllabifiable segments, as in the cases of /s/ in the /s/ + stop clusters in Sanskrit, Greek, etc., and English coronal codas. It needs further research to determine whether feature-deletion is involved in unsyllabifiable segments. Many coda rules involve feature-addition as in Japanese and Hausa.

[5] The scale in (16) also allows /sr/, which is not attested in the language.

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