The Life Cycle of Voiceless Sonorants:  
A Study in Differential Phonologization

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I. VOICELESS SONORANTS: FOUR KINDS, ONE PROBLEM

(1) Four kinds of voiceless sonorants

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>COVER SYMBOL</th>
<th>SAMPLE SEGMENTS</th>
<th>FEATURE MAKE-UP*</th>
<th>σ -POS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voiceless laryngeal glide</td>
<td>h</td>
<td>/h/</td>
<td>[+SG,-vd] [+son,-cons] no PL</td>
<td>free</td>
</tr>
<tr>
<td>Other voiceless glides</td>
<td>W̥</td>
<td>/W̥, j/</td>
<td>[+SG,-vd], [+son,-cons], PL</td>
<td>non-Nuc</td>
</tr>
<tr>
<td>Voiceless sonorant consonants</td>
<td>R̥</td>
<td>/l̥, m̥/</td>
<td>[+SG,-vd], [+son,+cons], PL</td>
<td>non-Nuc</td>
</tr>
<tr>
<td>Voiceless vowels</td>
<td>V̥</td>
<td>/i̥, u̥/</td>
<td>[+SG,-vd], [+son,-cons], PL</td>
<td>Nuc</td>
</tr>
</tbody>
</table>

*[+SG] = [+spread glottis]; PL = Place. Other feature specifications are possible, but a minimal system of three laryngeal features is necessary to distinguish phonological contrasts between plain modal voice, breathy voice, creaky voice and voiceless sonorants.

(2) Frequency, distribution and contrastive status of voiceless sonorants

As phonetic segment types, voiceless sonorants are extremely common, though often overlooked. For example in many languages with /sR̥/ clusters, R̥ a sonorant, R is phonetically voiceless (e.g. English [s̥n̥æk], [s̥l̥æk], [s̥m̥æk]). However, as contrastive segments, there is an interesting typological asymmetry:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FREQUENCY (MADDIESON 1984)</th>
<th>GENETIC/AREAL DISTRIBUTION</th>
<th>CONTRASTIVE STATUS</th>
<th>IMPLICATIONS FOR SEGMENT INVENTORY?</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>279/317 63.6%</td>
<td>all major language families</td>
<td>very common</td>
<td>none</td>
</tr>
<tr>
<td>W̥</td>
<td>11/317 .035%</td>
<td>South-East Asia; Northwest NA; Meso-America</td>
<td>uncommon</td>
<td>if W̥ then W̥; /h/</td>
</tr>
<tr>
<td>R̥</td>
<td>.006</td>
<td>(Nilo-Saharan) (Sino-Tibetan)</td>
<td>rare/unattested*</td>
<td>If V̥ then V̥; /h/</td>
</tr>
</tbody>
</table>

*Maddieson (1984) lists Ik (Nilo-Saharan) and Dafla (Sino-Tibetan) as having contrastive voiceless vowels. See below for details.
(3) Some phonetic properties of voiceless sonorants

Chomsky and Halle (1968:302) define sonorant sounds ([+sonorant]) as those produced with a vocal tract cavity configuration in which spontaneous voicing is possible, while obstruents ([−sonorant]) have cavity configurations which make spontaneous voicing impossible. Stevens (1983:254) enhances these definitions by referring directly to aerodynamic pressure increase in obstruents and associated turbulent noise (during closure or release), and the absence of this intraoral air pressure and associated noise in sonorants. In later work inhibition of vocal fold vibration is noted as a mechanical effect of air pressure increase in obstruents (Stevens 1997:490).

The articulation of voiceless sonorants, like modal voiced sonorants, involves approximately equal air pressure above and below the glottis, with no significant increase of intra-oral air pressure. However, since vocal folds are not in their neutral position, there is no modal voicing. Instead, vocal folds are widely spread at the arytenoid cartilages, or there some other glottal devoicing gesture, while in modally voiced sonorants there is none. In general, no vocal cord vibration is present and longitudinal tension, medial compression and adductive tension are minimal, though, in some cases, vocal cords vibrate at low amplitude despite glottal aperture. Depending on glottal area and transglottal airstream turbulence, frication can arise. (Ladefoged 1971; Gordon and Ladefoged 2001; Bombien 2006; Tucker and Warner 2010).

Acoustic properties associated with voiceless sonorants include: greater duration of voiceless sonorants than voiced sonorants; increased spectral noise at higher frequencies; decrease in overall acoustic intensity; fall of energy at higher frequencies (negative spectral tilt, in contrast to modal voice with intermediate values, and positive values for creaky voice); possible raising of fundamental frequency; possible shifts in formant frequencies (Maddieson & Anderson 1994; Gordon and Ladefoged 2001; Turnbull et al. 2011).

(4) Non-contrastive status of voiceless vowels

A. Ik (Kuliak), Karamojong, Teso, Turkana (Eastern Nilotic) and other Nilo-Saharan

Though Heine (1975) and Dimmendall (1982, 1983) suggest that Turkana has a contrast between word-final voiced and voiceless vowels, this analysis is dubious, for the following reasons, as suggested by Schrock (2011:7-8) for Ik and other languages of the NE Uganda, NW Kenya region:

i. Voiceless vowels are limited to word-final position and are voiceless only in phrase-finally before pause.

ii. Voiceless vowels are voiced when non-final in the phrase.

iii. In some languages, like Ik, the phrase-final reduced vowel variant can be voiceless or a short (voiced) schwa.

iv. In some languages, like Teso and Turkana, the vowels are not pronounced at all in phrase-final position.

v. In some languages, like Turkana, a phrase-final sequence of RV̥// is pronounced … R̥J with a final voiceless sonorant consonant allophone.

vi. In Ik and Toposo, nominal case-endings are often, but not always, voiceless when phrase-final.

vii. There are no minimal or near-minimal pairs distinguished only by voiced/voiceless vowel pairs.
B. Dafla (aka Nishi, a Sino-Tibetan Tani/Miric language) of the eastern edge of the Himalayas, bordering Tibet, Assam, Bhutan and Burma.

Though Ray (1967) reports word-final voiceless vowels, these are suspect phonemes because:

i. Their distribution is predictable: short /i/ is voiceless word-finally, voiced elsewhere; short /u/ is only voiceless word-finally when preceded by a voiceless consonant.

ii. DasGupta (1969), Tayeng (1990), Goswami (1995) and Abraham (2005) do not include voiceless vowels as basic (or derived) sounds.

iii. There is historical evidence for final vowel devoicing/reduction and loss, but not of contrastive voiceless vowels (Abraham 2005):

<table>
<thead>
<tr>
<th>Lower Region</th>
<th>Upper Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>at, atә</td>
<td>a:te</td>
</tr>
<tr>
<td>ix</td>
<td>ixi</td>
</tr>
<tr>
<td>ab</td>
<td>abu</td>
</tr>
<tr>
<td>an</td>
<td>ane</td>
</tr>
</tbody>
</table>

‘elder sister’
‘dog’
‘father’
‘mother’

C. Comanche (and other Numic/Uto-Aztecan) (Armagost and Miller 2000)

“Organic” devoicing occurs when a short (unclustered, unstressed, non-stem-initial) vowel obligatorily assimilates to a following /h/ or /s/:

i. kohno ‘cradle’

haβi-kǭno ‘night cradle’

ii. tosa ‘white’

to-tǭsa ‘white’ (RED)

However, if a vowel is in a context where it should be devoiced before /h/ and it is preceded by a voiced consonant, the vowel is lost, and there is Dh > hD metathesis:

iii. /na-juhu/ [nahju] ‘oil’

iv. /wa-waha/ [wahwa] ‘twins’ < ‘two (RED)’

v. /ku(h)-tsa(h)-wihi/ [kuhtsahwi] ‘to throw in the fire’

*[kuhstʃwi]

Forms like v. suggest that organic devoicing precedes metathesis, since the bolded vowel is in a context for organic devoicing but does not devoice. Clearly, organic devoicing is losing surface transparency. Debate centers on the extent to which organic voiceless vowels can all be attributed to underlying /h/ which often does not surface.

“Inorganic” devoicing targets short (unclustered) pre-pausal vowels, and is optional. If devoicing occurs, glides, nasals and fricatives preceding the voiceless vowel are also devoiced. There is no question that inorganic voiceless vowels are predictable allophones of voiced vowels.
(5) General explanations for synchronic distribution of linguistic features

The State-Process Model (Greenberg 1966, 1969, 1978): For any state of a natural human language there must be (i) at least one process leading to that state; and (ii) at least one process leading from it to a different state. If this is the case, then synchronic distribution of linguistic features offers insight into their rates of diachronic innovation and transmission. High frequency features may be frequently innovated, robustly transmitted or both. Rare features may be rarely innovated, poorly transmitted, or both. Genetically and areally distributed linguistic features can be highly suggestive of innovation and transmission rates. If a feature clusters within related languages or in language areas, especially where there is thought to be significant time depth, the feature shows diachronic fitness, persisting over time, and (in cases of areal features) spreading to unrelated languages. If, on the other hand, there is random distribution of a feature within a language or area, this suggests poor transmission, genetically and/or laterally.

Evolutionary Phonology (Blevins 2004, 2006, 2008): A sound or sound pattern $S$ may be rare because (i) there is no sound change $XYZ \rightarrow XSY$, or this sound change itself is rare; or because (ii) there is a common sound change $XS Y \rightarrow XZY$. Clicks appear to be rare because they rarely originate via natural phonetically-based sound change from non-click sounds; however, once evolved, they are relatively stable. Three-way contrasts in nasality or vowel length appear to be rare because they commonly morph into (or phonologize as) two-way contrasts.

(6) The Problem

i. Phonetic vowel devoicing is extremely common among unrelated languages with predictable voiceless vowels occurring in two common contexts:
   a. phrase-final, pre-pausal
   b. adjacent to voiceless consonants (especially /h/ and /s/)

50 languages with voiceless vowels (Gordon 1998): Acoma, Ainu, Alabama, Apinaye, Awadhi, Azerbaijani, Bagirmi, Big Smokey Valley Shoshoni, Boraana Oromo, Bulu, Campa, Cheyenne, Chontal, Cocama, Comanche, Dafla, French (Montreal), Gadsup, Galla, Goajiro, Greek, Hupa, Ik, Inuit, Island Carib, Japanese, Kawaiisu, Ket, Korean, Malagasy, Mandarin, Mbay, Mixtec, Mokilese, Nyangumarta, Oneida, Papago, Portuguese (Brazilian), Quechua, Saami, Sara, Shina, Southern Paiute, Tarascan, Ticuna, Tongan, Totonac, Tubu, Tunicua, Turkana, Turkish, Tzeltal, Washkuk, Wolof, Zuni.

ii. Phonetic sonorant glide/consonant devoicing is extremely common among unrelated languages with predictable voiceless sonorants in occurring in two common contexts:
   a. phrase-final, pre-pausal
   b. adjacent to voiceless consonants (especially /h/ and /s/)

Angas, Camuno, English, Icelandic, Kishambaa Lenakel, Romanian, Tohono O’Odham, etc.

iii. Nevertheless, voiceless vowels rarely if ever phonologize, while voiceless sonorant consonants do (Table 2). Under the general models just sketched, this might be attributed to the fact that voiceless vowels delete more frequently than other voiceless sonorants, and do so before they can phonologize. However, the genetic and areal distribution of voiceless vowels in, e.g. Numic, Micronesian and the northern Uganda/Kenya region suggests some degree of diachronic persistence. How, then, do we explain this asymmetry in phonologization?
(7) Differential deletion?

The most common sound change that applies to voiceless vowels is deletion (Blevins 2004:199). However, the fact that voiceless vowels often delete does not explain why those that do not fail to phonologize. (It is unclear whether word-final voiceless vowels are any more or less likely to delete than word-final voiceless nasals or glides. Data in Dafla, reported in (4b), shows (voiceless) final vowel loss in one dialect; the same dialect shows loss of final (voiceless) /ŋ/.)

(8) Perceptual markedness?

Gordon (1998:93) suggests that “non-modal vowels are perceptually less robust than modal vowels and are therefore eschewed by many languages.” A universal constraint *NON-MOD V is proposed, but can be ranked above or below constraints demanding vowel devoicing on the basis of articulatory/aerodynamic ease. The same reasoning would lead to a similar constraint for other sonorants (*NON-MOD R). This synchronic analysis highlights a weakness of constraint-based grammars: since most are geared to generate surface allophones from underlying forms, or relate surface phones to phones, they are at a loss to explain why a particular phone should resist phonologization. In contrast, an evolutionary approach allows us to ask: what are the stages of phonologization, and how might differences in the phonetics of sonorant devoicing result in states that are incompatible with reanalysis of V̥ as something distinct from V?

II. THE EVOLUTION OF VOICELESS SONORANTS

(9) Prelude: Stages of phonologization in splits

Stage 1  XaY  VaW
Stage 2  Xa’Y  Va’W  a’ is a phonetic variant of a
Stage 3  XaY  Va’W  a’ is a predictable variant of a in context V_W
Stage 4  XaY  Qa’R  conditioning of a’ is opaque in Q_R

(10) Phrase-final, pre-pausal devoicing

Most likely due to decline in subglottal pressure across the utterance; in some languages, enhanced by phrase-final laryngeal spreading gestures (Blevins 2006)

i.  V > V̥ // (V̥ # > ø)  
ii.  R > R̥// (R̥# > ø)

Ainu vs. Woleaian vs. Trukese  Icelandic vs. Angas vs. Galambu (WChadic)

May progress from word-final to phrase-final, but, significantly, there is no evidence of phonologization of voiceless sonorants (R, W or V) in this context.
Why? Because (i) word-final conditioning remains transparent and (ii) in languages like Woleaiian, suffixation shows alternation between non-final voiced and final voiceless vowels:

\[
\begin{align*}
\text{mejã} & \quad \text{meja-fi} & \text{‘feel’/trans.} \\
\text{firé} & \quad \text{fire-xi} & \text{‘weave’/trans.}
\end{align*}
\]

(11) Gestural spreading, segmental fusion

A great deal of work explores the hypothesis that in HR clusters, H an aspirate (/h/, /s/, aspirated stops), and R a sonorant, sonorant devoicing is a consequence of gestural overlap or sharing of a single laryngeal aspirating gesture (e.g. Gordon 1998; Tsuchida et al. 2000, Bombien 2006, Tucker and Warner 2010).

i. \( V > \overset{\text{V}}{H} \)  \hspace{1cm} ii. \( R > \overset{\text{R}}{H} \)  \( (\overset{\text{RH}}{H}, \overset{\text{HR}}{R} > \overset{\text{R}}{R}) \)

Voiceless vowels can arise in this way, as in the organic vowels of Comanche (4c), where, historically, there is evidence of (i), with vowel devoicing before \{h,s\}.

Voiceless sonorants also commonly evolve this way, but interestingly, with a twist: unlike vowels where a VC or CV sequence is maintained, a simultaneous or subsequent sound change *merges* the sonorant + aspirate into a single segment, as in Kokota, an Oceanic language of the Solomons (Palmer 1999, 2009):

\[
\begin{array}{ccc}
\text{Zabana} & \text{Kokota} \\
*\text{namaha} & \text{namaha} & \text{naŋa} & \text{‘love’} \\
*\text{komuhu} & \text{komuhu} & \text{koŋu} & \text{‘season/year’} \\
*\text{naroho} & \text{naroho} & \text{naŋo} & \text{‘rope’}
\end{array}
\]

This segmental merger explains certain phonetic properties of voiceless sonorants:

a) voiceless-voiced (Tibeto-Berman) or voiced-voiceless (Kokota) contours
b) longer segment durations

The answer to why voiceless vowels rarely phonologize seems directly related to a simple difference between (11i) and (11ii) above: gestural overlap between a vowel and /h/ is less likely to be interpreted as a single V segment because of phonotactic constraints of a given language, and the fact that, given that all languages have /h/, there is always the possibility of the /hV/ or /Vh/ interpretation. In contrast, in all languages where CC clusters occur, a single C can occur as well, so overlapped gestures can always be interpreted as single Cs.

\[
\begin{align*}
i. \quad \text{kohno ‘cradle’} & \quad \text{haβi-kọno ‘night cradle’} \\
ii. \quad \text{tosa ‘white’} & \quad \text{to-tọsọ ‘white’ (RED)}
\end{align*}
\]
(12) Obstruent weakening (not relevant to vowels)

i. ɬ > l̥ii. ɸ > w̥iii. r̋ > r̥̥

Tahltan (Shaw 1991) Maori ??

Selected References


STEDT lexical database. http://stedt.berkeley.edu


