Regarding the sonority of liquids

Clàudia Pons-Moll
1. STATE OF THE AFFAIRS

(1) The role of the sonority scale in phonology

Parameter to account for syntagmatic relations between segments:

→ organization of segments within the syllable
  — Sonority Sequencing Principle: «Segments are syllabified in such a way that sonority increases from the margin to the peak.» (See, among others, Clements 1990)
  — Sonority Dispersion Principle: «Sonority is maximally dispersed in the initial demisyllable and minimally dispersed in the final demisyllable.» (See, among others, Clements 1990)

→ organization of segments across syllables
  — Syllable Contact Law: «Sonority drops maximally across syllable boundaries» (See, among others, Clements 1990)

(2) Uncontroversial relative sonority of segments

VOWELS > GLIDES > LIQUIDS > NASALS > OBSTRUENTS

5 4 3 2 1


(3) Controversial relative sonority of segments

a. LATERALS vs. RHOTICS
   laterals > rhotics
   rhotics = laterals

b. FRICATIVES vs. STOPS
   fricatives > stops
   fricatives = stops

c. VOICED OBSTRUENTS vs. VOICELESS OBSTRUENTS
   voiced obstruents > voiceless obstruents
   voiced obstruents = voiceless obstruents
   voiced fricatives > voiceless fricatives > voiced stops > voiceless stops
   voiced fricatives > voiceless fricatives = voiced stops > voiceless stops

d. STOPS vs. AFFRICATES vs. FRICATIVES
   fricatives > affricates > stops
   fricatives = affricates > stops
   fricatives > affricates = stops

e. GLOTTALS

(See Parker 2002, for extensive discussion on this subject)

(4) Circular arguments

Specific phonological pattern

Specific distribution of segments in the sonority scale

Some critical reviews on sonority

«Segments are assigned to sonority classes on the basis of their distribution within the syllable, but syllabification itself is usually formulated in terms of sonority» (Walther 1993)

«The circularity would be avoided if the ‘sonority’ of segments were definable in some way that was independent of their position in this hierarchy. But this is not the case; sonority has never been satisfactorily defined […] Furthermore, there are no prospects that anyone is even getting close to solving this problem —except, perhaps, by abandoning it and invoking an entirely new notion to explain segment sequences.» (Ohala 1990, 1992)

(See Parker 2002, for extensive discussion on this subject)

(5) The sonority scale: universal or language-particular?

→ Universal, categorical and impermutable

→ Language-particular, gradient and permutable

(6) Arguments for a more flexible and gradient approach to the sonority scale

a) The specific phonetic properties of each sound and each class of sounds can fluctuate from one language to another (and, also, from one dialect to another), although the given label coincides. (→ Slightly different sonority values / relative sonority)

— Example: RHOTIC SOUNDS

Voiced dental or alveolar trill

r
Voiced dental or alveolar tap or flap \( \epsilon \)  
Voiced dental or alveolar approximant \( \eta \)  
Voiced post-alveolar flap \( \zeta \)  
Voiced post-alveolar approximant \( \zeta \)  
Voiced uvular trill \( \chi \)  
Voiced uvular approximant \( \chi \)  
Voiced dental or alveolar lateral flap \( \lambda \)  

(Ladefoged & Maddieson 1996: 216)

b) The specific phonetic features of each sound can (slightly) vary depending on the structural position that it occupies. (→ Slightly different sonority values / relative sonority)

— For rhotics, see, for instance, Recasens & Espinosa (2007): «Phonetic typology and positional allophones for alveolar rhotics in Catalan»

— For laterals, see, for instance, Recasens (2005): «Articulatory, positional and coarticulatory characteristics for clear /l/ and dark /l/: evidence from two Catalan dialects»

c) The relative sonority of sounds can diverge depending on the phonetic context.

— Larson (1993), for instance, proposes a model in which sonority is considered not absolute, but the result of a mutual (bidirectional) excitation between adjacent segments. (Sonority → syntagmatic feature)

d) The relative sonority of sounds can oscillate depending on the physiological attributes of the speakers: in Parker (2002), slight sound sonority differences are detected in males and females.

*********************************

e) Unlike what is tacitly assumed in traditional approaches to the sonority scale, the sonority distance between different pairs of categories in the hierarchy has not necessary to be the same.

— «... the values are purely relational: the distance between each niche in the hierarchy has the same value. It is not unlikely that this is the wrong approach, and that the sonority distances between segments of lesser sonority are smaller than those between segments of greater sonority, that is, that there are significant discontinuities in the sonority hierarchy» (Selkirk 1984: 121)

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Regarding the sonority of liquids: Some evidence from Romance

f) Languages do not share the same segment inventories, so that the relative sonority distances between sounds across languages may be different.

g) Languages can make an equal or a different phonological use of the same physical properties of speech sounds (see Morén 2007).

(7) Parker (2002)

— Phonetically grounded sonority scale
— Verified through psycholinguistic experiments

\[
\begin{array}{c}
\text{Intensity} \\
\text{Peak intraoral air pressure} \\
\text{F1 frequency} \\
\text{Peak air flow} \\
\text{Duration}
\end{array}
\]

\( \text{physical correlates of sonority} \)

Cf. «The sonority of a sound is its loudness relative to that of other sounds with the same length, stress and pitch.» Ladefoged (1993)

(8) Phonetically grounded / universal sonority scale

<table>
<thead>
<tr>
<th>low vowels</th>
<th>mid vowels</th>
<th>high vowels</th>
<th>[a]</th>
<th>glides</th>
<th>laterals</th>
<th>flaps</th>
<th>trills</th>
<th>nasals</th>
<th>/h/</th>
<th>voiced fricatives</th>
<th>voiced stops</th>
<th>voiceless fricatives</th>
<th>voiceless stops</th>
<th>affricates</th>
</tr>
</thead>
</table>

(Parker 2002: 236)

«Most languages in fact conflate the scale in the sense that they do not systematically exploit all the intervals. This is because they either lack the respective phoneme(s) entirely, or else they collapse together two or more adjacent ranks and thus do not distinguish them in terms of their phonological processes». (Parker 2002: 236)

(9) Jany, Gordon, Nash, Takara (2007)

— Calculation of sound’s intensity in 4 languages (Egyptian Arabic, Hindi, Mongolian and Malayalam).

— Disputed sonority contrasts, such as a) laterals vs. rhotics, b) voiceless fricatives vs. voiced stops, c) affricates vs. stops, and d) sibilants vs. other fricatives, follow language-specific patterns.

— Undisputed contrasts, such as sonorants > obstruents, are cross-linguistically consistent in their acoustic patterns.
2. GOALS

The purpose of this talk is twofold. — On the one hand, focusing on some familiar phonological patterns of liquids in Romance varieties and, also, on some other phenomena less well-known, we prove that the sonority scale proposed by Parker (2002) for these segments leads to the correct predictions in most cases, but not in all. [In this talk]
— On the other hand, taking these data as illustration, we aim to discuss which sonority conflations and reversals across languages should be possible and which should not [not in this talk], and how these language specific details could be formalized. [In this talk]

3. DATA AND DISCUSSION

(10) Liquids

VOWELS > GLIDES > LIQUIDS > NASALS > OBSTRUENTS

(See 2)

(11) Rhotics and laterals

VOWELS > GLIDES > RHOTICS > LATERALS > NASALS > OBSTRUENTS

(See 3)

(12) Regressive manner assimilation asymmetries in Italian

val+rà [várrà] ‘(he/she) will be valid’
dol+rà [dórrà] ‘(he/she) will feel pain’

(See 2)

Phonological sonority pattern: \( r > l \)

(13) On the relation between the tap [\( r \)] and the trill [\( r \)]

LATERALS, TAPS > TRILLS

There is not a single instance in which the mean value for /\( r \)/ is significantly more “sonorous” than that of /\( r \)\( \text{r} \)\( \) (Parker 2002: 233)

(14) Distribution of rhotics in Romance

<table>
<thead>
<tr>
<th></th>
<th>Spanish</th>
<th>Portuguese</th>
<th>Catalan</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) stem-initial position → trill</td>
<td>[t( r )( \text{z} )( ) &amp; [t( r )( \text{j} )( )]( )</td>
<td>[t( r )( \text{z} )( ) &amp; [t( r )( \text{j} )( )]( )</td>
<td>1 NASALS</td>
</tr>
<tr>
<td>b) onset position, after a het. C → trill</td>
<td>[( \text{t} )( \text{r} )( \text{h} )( ) &amp; [( \text{t} )( \text{r} )( \text{h} )( ]( ])</td>
<td>[( \text{t} )( \text{r} )( \text{h} )( ]( ])</td>
<td>2 LATERALS</td>
</tr>
<tr>
<td>c) second position of an onset → tap</td>
<td>[( \text{f} )( \text{r} )( ) &amp; [( \text{f} )( \text{r} )( ]( ])</td>
<td>[( \text{f} )( \text{r} )( ]( ])</td>
<td>3 GLIDES FLAPS</td>
</tr>
<tr>
<td>d) coda position → tap ~ trill</td>
<td>[( \text{m} )( \text{r} )( \text{r} )( ]( ]) &amp; [( \text{m} )( \text{r} )( \text{r} )( ]( ])</td>
<td>[( \text{m} )( \text{r} )( \text{r} )( ]( ])</td>
<td>4 VOWELS</td>
</tr>
</tbody>
</table>

(Sonority Dispersion Principle: «Sonority is maximally dispersed in the initial demisyllable and minimally dispersed in the final demisyllable» (Clements 1990, 2006)

Phonological sonority pattern: \( r > r \)

(15) Onset /\( r \)/ trilling in North-Eastern Catalan

(15a) Stem-final glide + future and conditional morph(eme)s → preservation

caurà /k\( w \)\( r \)\( \) & [k\( w \)\( r \)\( ]\( ]\) | ‘(he/she) will fall down’
cauria /k\( w \)\( r \)\( i \)\( ]\( ]\) & [k\( w \)\( r \)\( i \)\( ]\( ]\) | ‘(he/she) would fall down’
traurà /t\( r \)\( w \)\( r \)\( ]\( ]\) & [t\( r \)\( w \)\( r \)\( ]\( ]\) | ‘(he/she) will take out’
trauria /t\( r \)\( w \)\( i \)\( ]\( ]\) & [t\( r \)\( w \)\( i \)\( ]\( ]\) | ‘(he/she) would take out’

(15b) Stem-final stop + future and conditional morph(eme)s → syllabification to the onset

prometrà /p\( r \)\( u \)\( m \)\( t \)\( r \)\( ]\( ]\) & [p\( r \)\( u \)\( m \)\( t \)\( r \)\( ]\( ]\) | ‘(he/she) will promise’
prometria /p\( r \)\( u \)\( m \)\( t \)\( i \)\( ]\( ]\) & [p\( r \)\( u \)\( m \)\( t \)\( i \)\( ]\( ]\) | ‘(he/she) would promise’

(15c) Stem-final nasal or lateral + future and conditional morph(eme)s → trilling (as a strategy to minimize the intersyllabic sonority rise)

venò /b\( n \)\( r \)\( ]\( ]\) & [b\( n \)\( r \)\( ]\( ]\) | ‘(he/she) will sell’
venòia /b\( n \)\( r \)\( i \)\( ]\( ]\) & [b\( n \)\( r \)\( i \)\( ]\( ]\) | ‘(he/she) would sell’
Regarding the sonority of liquids: Some evidence from Romance

Phonological sonority pattern: \( r > \) 

\[
\begin{array}{cccccc}
\text{/tem+re/} & \text{*DIST +2} & \text{*DIST +1} & \text{DIST 0} & \text{ IDENT(Manner)} & \text{DIST –1} \\
\hline
\text{a.} [\text{təm.ɾe}] & *! & * & * & * & * \\
\text{b.} [\text{təm.ɾe}] & * & * & * & * & * \\
\hline
\text{/kal+ria/} \\
\hline
\text{a.} [\text{kəl.ɾiə}] & *! & * & * & * & * \\
\text{b.} [\text{kəl.ɾiə}] & * & * & * & * & * \\
\end{array}
\]

Assumed sonority scale (see 13):

VOWELS > GLIDES > LATERALS, TAPS >> TRILLS > NASALS > FRICATIVES > STOPS

\[
\begin{array}{cccccc}
\text{DIST 0} & \text{DIST +1} & \text{DIST –1} & \text{DIST +2} \\
\text{DIST 0} & \text{DIST +1} & \text{DIST –1} & \text{DIST +2} \\
\end{array}
\]

(15d)

(16) Evolution of Latin clusters N’R and L’R

\[\text{a. Catalan (North-Eastern & Majorcan)} \quad \text{b. Catalan (most varieties)}\]

\[\rightarrow \text{Onset trilling} \quad \rightarrow \text{Epenthesis} \quad \rightarrow \text{Metathesis}\]

\[
\begin{array}{cccccc}
\text{TEN(ER)U} & > & [\text{têr.n}] & \text{TEN(ER)U} & > & [\text{têr.dra}] \quad \text{‘tender’} \\
\text{DIE VENETIS} & > & [\text{dvêr.nəs}] & \text{DIE VENETIS} & > & [\text{dvêr.dəs}] \quad \text{‘Friday’} \\
\end{array}
\]

Phonological sonority pattern: \( r > r \)

(17) Blocking of apheresis in Catalan

\[\text{a.} \quad \text{b.} \quad \text{c.}\]

\[
\begin{array}{cccccc}
[\text{ɾ}% & \rightarrow & \text{narr} & \rightarrow & \text{nar} & \rightarrow & \text{nar} \\
[\text{ɾ}% & \rightarrow & \text{gafar} & \rightarrow & \text{gafar} & \rightarrow & \text{gafar} \\
[\text{ɾ}% & \rightarrow & \text{eglar} & \rightarrow & \text{eglar} & \rightarrow & \text{eglar} \\
[\text{ɾ}% & \rightarrow & \text{oma} & \rightarrow & \text{oma} & \rightarrow & \text{oma} \\
\end{array}
\]


Phonological sonority pattern: \( r > r \)

(18) Hypocoristic formation in Catalan

\[\text{a.} \quad \text{b.} \quad \text{c.}\]

\[
\begin{array}{cccccc}
\text{Josefina} & \rightarrow & \text{Fina} & \rightarrow & \text{Fina} & \rightarrow & \text{Fina} \\
\text{Montserrat} & \rightarrow & \text{Rat} & \rightarrow & \text{Rat} & \rightarrow & \text{Rat} \\
\text{Francisco} & \rightarrow & \text{Cisco} & \rightarrow & \text{Cisco} & \rightarrow & \text{Cisco} \\
\text{Joaquim} & \rightarrow & \text{Quim} & \rightarrow & \text{Quim} & \rightarrow & \text{Quim} \\
\end{array}
\]

(Data from Cabré 1993)
Phonological sonority pattern: \( r > r \)

**INTERIM RESULTS:** The phonological patterns related to trills and taps in the Romance varieties analyzed are totally consistent with the experimental results in Parker (2002).

(19) On the relation between the tap \( [r] \) and the lateral \( [l] \)

«Specifically, \( /l/ \) patterns as more sonorous than the flap \( /r/ \) 10 times, as equivalent 7 times, and as less sonorous in 3 cases. The flap \( /r/ \) in turn outranks the trill 9 times and ties with it only once. There is not a single instance in which the mean value for \( /r/ \) is significantly more “sonorous” than that of \( /l/ \) » (Parker 2002: 233)

(20) Structural distribution in (most) Romance languages

| a) stem-initial position | \( \rightarrow \) lateral |
| b) onset position, after a het. C | \( \rightarrow \) lateral |
| c) second position of an onset | \( \rightarrow \) lateral / tap |
| d) coda position | \( \rightarrow \) lateral / tap |

(21) Catalan complex onset structure

**C1**: \([p], [t], [k], [b] / [f], [d] / [g] / [y], [f]\)  
**C2**: \([r]\)

(Data from Bosch 1999)

→ Diachronic process of rhotacism of \( [l] \) as an onset sonority maximization strategy

**Assumed sonority scale in (15d):**

| VOWELS > GLIDES > LATINALS, TAPS > TRILLS > NASALS > FRICATIVES > STOPS |
|-------|-------|-------|-------|-------|
| 7     | 6     | 5     | 4     | 3     |

| = INTRASYLLABIC DISTANCE |

— What explains, therefore, the avoidance of OBSTRUENTLATERAL onset clusters?

**Phonological sonority pattern: \( r > l \)**

| VOWELS > GLIDES > TAPS > LATINALS > TRILLS > NASALS > FRICATIVES > STOPS |
|-------|-----------|-------|-------|-------|
| 7     | 6         | 5     | 4     | 3     |

| # INTRASYLLABIC DISTANCE |

—
Regarding the sonority of liquids: Some evidence from Romance

Phonological sonority pattern: \( r, \tilde{f} > 1 \)

### (25) Lateral rhotacism in complex onsets in Galician

- FLACCUS > [fr]aco ‘slim’
- FLUXUS > [fr]ouxo ‘loose’
- ECCLESIA > [fr]esia ‘church’
- PLATEA > [pr]aza ‘square’
- PLACERE > [pr]acer ‘pleasure’

(Cf. FLUvia > chvia ‘rain’; CLAMARE > chamar ‘to call’; PLORARE > chorar ‘to cry’; FLAMMA > chama ‘flame’)

(Data from Frexeiro 1998: 184)

### (26) Lateral rhotacism in complex onsets in Galician (variation)

- claridade [klaɾiˈdade] ~ [kraɾiˈdade] ‘brightness’
- explicar [esplikar] ~ [esprikar] ‘to explain’
- gloria [glórija] ~ [grórija] ‘glory’
- inclinado [inklinado] ~ [inkarinado] ‘inclined’
- clase [klás] ~ [krás] ‘class’
- amables [amábles] ~ [amábres] ‘kind plur.’
- plomo [plómo] ~ [prómo] ‘lead’

(Data from Frexeiro 1998: 184)

Phonological sonority pattern: \( r > 1 \)

### (27) Lateral rhotacism in European Portuguese

- blanco [brˈaŋko] ‘white’
- plato [prˈato] ‘dish’

Phonological sonority pattern: \( r > 1 \)

### (28) Additional evidence

**a. Syncope in Catalan**

- barana [brˈaŋa] ‘handrail’
- taronja [tɾaɾojya] ‘orange’
- berenar [bɾəˈnə] ‘breakfast’
- Teresa [tɾəˈza] ‘Teresa’
- veritat [bɾəˈtʃat] ‘truth’
- interes [iŋˈtɾəs] ‘interest’
- parany [prˈaŋ] ‘trap’
- garatge [ɡɾətʃe] ‘parking’

(Data from Wagner 1941, Bolognesi 1998, Frigeni 2004)
Regarding the sonority of liquids: Some evidence from Romance

(29) Lateral rhotacism between vowels in Alguerese Catalan

a. Word-internally
   - ala [aa] ‘wing’
   - cala [kára] ‘creek’
   - sala [saa] ‘room’

   - tele [táwa] ‘row’
   - fila [ﬁa] ‘line’
   - mola [mua] ‘mule’

b. Across words (involving clitics)
   - a l’escola [a r askíla] ‘in the school’
   - per la mare [pe ra mára] ‘for the mother’
   - me la dóna [ma ra dúna] ‘(he/she) gives it to me’
   - vol [vɔl] ~ voliva [vuríva] ‘(he/she) wants ~ (he/she wanted)’

   - vol [vɔl] ~ voliva [vuríva] ‘(he/she) wants ~ (he/she wanted)’

Cf. Intervocalic /r/: ara [árə]; pare [pára]; cara [kára]; mare [mára]
(Data from Bosch 2002)

(30) Dental stop rhotacism between vowels in Alguerese Catalan

a. Word-internally
   - cada [kára] ‘each’
   - cala [kára] ‘creek’
   - sala [saa] ‘room’


b. Synchronic productivity
   - convid [kumvi[t] ‘(I) invite’ ~ convidar [kunyvi[r] ‘to invite’
   - vida [vi[r] ‘life’ (Data from Bosch 2002)

(31) Lateral rhotacism between vowels in Sardinian

(a. Word-internally)
   - calori [karóri] ‘hot’
   - soli [sóri] ‘sun’
   - scola [skóra] ‘school’
   - ala [ára] ‘wing’
   - mela [méra] ‘almond’
   - fila [ﬁra] ‘line’
   - taula [táwra] ‘table’

   (Data from Peana 1995)

— The prominence hierarchy for consonants in intervocalic position is that of peaks, not that of margins (Uffmann 2005)

Prominence hierarchy for consonants in intervocalic position
(adapted to the sonority scale in 21)

\[ *V_1V / STOPS >> *V_1V / FRICATIVES >> *V_1V / NASALS >> *V_1V / TRILLS >> *V_1V / LATERALS >> *V_1V / TAPS >> *V_1V / GLIDES \]

<table>
<thead>
<tr>
<th>/mal+a/</th>
<th>*V_1V / STOPS</th>
<th>*V_1V / LATERALS</th>
<th>IDENT (Manner)</th>
<th>*V_1V / TAPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [mála]</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| b. [mára] | * | | | *

<table>
<thead>
<tr>
<th>/amad+a/</th>
<th>*V_1V / STOPS</th>
<th>*V_1V / LATERALS</th>
<th>IDENT (Manner)</th>
<th>*V_1V / TAPS</th>
</tr>
</thead>
</table>
| a. [amáda] | ! | | | *
| b. [amára] | * | | | *

INTERIM RESULTS: The phonological patterns related to laterals and taps in the Romance varieties analyzed are not totally consistent with the sonority scale proposed in Parker (2002), since the tap generally patterns as more sonorous than the lateral, but they are consistent with his experimental results (see 18).
(32) On the relation between the lateral [l] and the trill [r]

LATERAL > TRILL

(Parker 2002: 233)

(33) Structural distribution in (most) Romance languages

a) stem-initial position → lateral / trill
b) onset position, after a het. C → lateral / trill
c) second position of an onset → lateral
d) coda position → lateral / trill

Phonological sonority pattern: l > r

(34) Rhotic (trill) lateralization in Alguerese Catalan

a. Word-internally

germana [dʒəl.mə.nə]‘sister’
part [pəlt]‘part’
tarda [təlda]‘afternoon’
març [mətʃ]‘March’
curt [ku:t]‘short’

b. Synchronic productivity

altar [altər] ~ altar major [altəl.madʒər]‘altar’ ~ ‘high altar’
segur [səgu:r] ~ segurs [səgu:rs]‘safe sing.’ ~ ‘safe plur.’
altər [altər] ~ altər [altəl’s]‘altar sing.’ ~ ‘altar plur.’
mor [mɔr] ~ mor [mɔrt]‘(he/she) dies’ ~ ‘(he/she) has died’

Phonological sonority pattern: l > r

(35) Manner assimilation patterns in Majorcan and Minorcan Catalan

(35a) Potential intersyllabic rising sonority
→ manner assimilation

a. Stop + non-stop consonant
  cap lit /kəp#lit/ [kəpˈlit] ‘any bed’
  cap iot /kəp#iot/ [kəpˈiət] ‘any yacht’
  llac petit /lak#pe’tit/ [lakˌpəˈtit] ‘small lake’

b. Alveolar fricative + lateral, rhotic, glide
  dos llits /doz#lits/ [dozˌlɪts] ‘two beds’
  dos rius /doz#rius/ [dozˌriʊs] ‘two yachts’
  dos iots /doz#iots/ [dozˌiəts] ‘two threads’

c. Nasal + lateral, glide
  un llum /uŋ#lum/ [uŋˌlʊm] ‘one light’
  un iot /uŋ#iət/ [uŋˌiət] ‘one yacht’
  un foc /uŋ#fʊk/ [uŋˌfʊk] ‘one fire’

Phonological sonority pattern: l > r

(35b) Flat or decreasing intersyllabic sonority
→ manner preservation

a. Stop + stop
  cap tros /kəp#troʊs/ [kəpˌtroʊs] ‘any piece’
  llac petit /lak#pe’tit/ [lakˌpəˈtit] ‘small lake’

d. Stop + stop
  cap tros /kəp#troʊs/ [kəpˌtroʊs] ‘any piece’
  llac petit /lak#pe’tit/ [lakˌpəˈtit] ‘small lake’

Why?

Phonological sonority pattern: l > r

INTERIM RESULTS: The phonological patterns related to trills and laterals in the Romance varieties analyzed are totally consistent with the experimental results in Parker (2002).
4. CONCLUDING REMARKS AND TENTATIVE PROPOSAL

(36) Experimental results in Parker (2002):

LATERALS > TAPS > TRILLS

(37) Phonological patterns in the Romance varieties analyzed:

TAPS > LATERALS > TRILLS

(38) Tentative proposal

— Standard OT

(38a) Ordinary categorical (non-variable) ranking:

\[ C1 \gg C2 \gg C3 \]

— Boersma & Hayes (2001) \rightarrow Stochastic OT (free variation & gradual learning)

(38b) Categorical ranking along a continuous scale

\[
\begin{array}{c|c|c}
\text{C1} & \text{C2} & \text{C3} \\
\hline
\text{Strict} (\text{high ranked}) & 100 & 90 & 80 & 70 & 60 & 50 & 40 & 30 & 20 & \text{Lax} (\text{low ranked}) & 10 \\
\end{array}
\]

(38c) Categorical ranking with ranges: C1 \gg C2

— Frequency effects

C2 \gg C3 (more likely)
C3 \gg C2 (less likely)

— Adaptation of the stochastic model to the organization of segments in the sonority scale

(38d) Free ranking (when ranges overlap): C2 \gg C3; C3 \gg C2

(38e) Evaluation time X: C2 \gg C3 (common result)

Selection point for C2 (above 35)
Selection point for C3 (below 35)

(38f) Evaluation time Y: C3 \gg C2 (rare result)

Selection point for C3 (above 35)
Selection point for C2 (below 35)

— Frequency effects

C2 \gg C3 (more likely)
C3 \gg C2 (less likely)

— Adaptation of the stochastic model to the organization of segments in the sonority scale

(38g) Organization of segments in the sonority scale

\rightarrow non-discrete, dense and gradient nature
(38f) Each specific sound covers a range of values in the sonority scale, and this range can be shared with that of another sound (→ ranges overlap).

(38g) In these cases, a different phonological interpretation of the relative sonority of the sounds across languages (i.e., a different sonority hierarchy) is allowed and expected.

(38h) The consequence of this is that the hierarchy of some sounds is more fixed than that of others in the sonority scale. Cf. [l], [r]

Language Y: [l] > [r] > [r] Language X: [r] > [l] > [r]

(38i) This account allows to make typological predictions about the cross-linguistic frequency of each hierarchy.

Cross-linguistic frequency of each hierarchy according to (38f)

| [l] > [r] > [r] (most likely) |
| [r] > [l] > [r] (less likely) |
| [l] > [r] > [r] (less likely) |
| [r] > [l] > [l] (less likely) |
| [r] > [l] > [l] (less likely) |
| [r] > [l] > [l] (least likely) |


