Lateral phonotactics in Australian languages

1. Introduction

Phonotactic restrictions on laterals:
- Laterals rarely appear word-initially.
- Laterals almost never appear postconsonantally.

Distribution is implicational: If laterals appear word-initially, they appear postvocally.
If laterals appear postconsonantally, they appear word-initially.

(1)  a. Panyjima  (Dench 1991)
    Lateral: {l l}  Word-initial: *{l} *{l} *{l}  Postconsonantal: *{l} *{l} *{l} *{k}

b. Anindilyakwa  (Leeding 1989)
    Lateral: {l k}  Word-initial: {l} {l}  Postconsonantal: *{l} *{l} *{l} *{k}

Problem: How should these restrictions be explained?

Two possible explanations:

Positional sonority restrictions (e.g. Gouskova 2002, 2003; Smith 2002)
Sonority properties of laterals predict their distribution.

Licensing by Cue (LBC; e.g. Jun 1995; Kochetov 1999; Steriade 1997, 1999)
The interaction of lateral acoustics with contextual acoustics predicts their distribution.

This paper will show that:

An analysis based on positional sonority restrictions can explain lateral distribution.
The acoustic properties of laterals do not support a Licensing by Cue analysis.

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2. A sonority-based account

2.1. Word-initial restrictions

Languages like Panyjima don’t allow laterals word-initially.

Smith (2002): Minimize the sonority of word-initial onsets, in order to maximize the perceptual salience of word beginnings.

(2) \[^{\text{ONSET}}_X/\sigma_1\] The leftmost premoraic segment in a word must have sonority less than that of X. (Smith 2002)

(3) \[^{\text{ONS/Glide}}/\sigma_1\] » \[^{\text{ONS/Rhotic}}/\sigma_1\] » \[^{\text{ONS/Lateral}}/\sigma_1\] » \[^{\text{ONS/Nasal}}/\sigma_1\] » \[^{\text{ONS/Stop}}/\sigma_1\] \uparrow

\text{IDENT}[F]^1

(on constraint hierarchies of this general type, see Prince and Smolensky 1993)

(4) \begin{array}{|c|c|c|}
\hline
\text{/lana/} & \[^{\text{ONS/Lateral}}/\sigma_1\] & \text{IDENT}[F] \\
\hline
\text{lana} & *! & * \\
\hline
\text{⇒ tana} & & * \\
\hline
\end{array}

This correctly predicts that when no laterals surface initially, no rhotics surface initially either.\(^2\)

Panyjima has no initial laterals or rhotics: *r *r *l *l *l *n *n *n

2.2. Postconsonantal restrictions

Languages like Panyjima and Anindilyakwa allow no laterals postconsonantally (i.e. as the second member of medial coda-onset clusters).\(^3\)

Theoretical preliminaries

- Parker (2002) found that the sonority values in (5) correlate with segments’ acoustic intensity.

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\(^1\) As this is a phonotactic effect, alternations provide no evidence about which faithfulness constraint bans initial laterals; I use IDENT[F] here, but MAX or DEP would work as well.

\(^2\) Factorial typology predicts that glides should occasionally fail to follow the general sonority-based phonotactic patterns that other consonants do, because glides also have vocalic ([V-Place]) features (Clements 1991). Formally, this means that the ranking IDENT[V-Place] » sonority restrictions » IDENT[F] is possible. Throughout Australian languages, it is possible for glides to surface word-initially and postconsonantally.

\(^3\) Restrictions against CL sequences must be syllable-contact effects because languages like Gooniyandi (McGregor 1990) have initial (tautosyllabic), but not medial (heterosyllabic), CL clusters: \textit{plan.pi.ta} ‘on one’s back’, but *\textit{kap.la}. 2

(6) *DISTANCE X The sonority difference between consonants in a heterosyllabic cluster may not be X.4

(7) \( \text{steep rise} \quad \overline{\text{flat}} \quad \overline{\text{steep fall}} \quad \rightarrow \)
\[
\ldots \star \text{DIST} +3 \rightarrow \star \text{DIST} +2 \rightarrow \star \text{DIST} +1 \rightarrow \star \text{DIST} 0 \rightarrow \star \text{DIST} -1 \rightarrow \star \text{DIST} -2 \rightarrow \star \text{DIST} -3 \ldots
\]
\[
e.g. \ star \text{m}.l \quad \star \text{t}.c \quad \star \text{t}.m
\]

Analysis of postconsonantal lateral restrictions

The ranking in (8) is necessary in order to appropriately describe the complete inventory of heterosyllabic clusters. This ranking independently predicts a lack of lateral-final clusters.

(8) *DIST +8 » *DIST +3 » *DIST +1 » *DIST 0 » *DIST -1 » *DIST -2 » **DIST -5
\( \text{e.g.} \ star \text{p}.l \quad star \text{m}.l \quad star \text{r}.l \quad \star \text{t}.l \quad star \text{r}.l \quad star \text{w}.l \quad \checkmark \text{n.c} \)

**DIST -5: The Panyjima cluster with the smallest (=worst) allowable sonority drop is N-Stop.

(9) \text{kan.ta} \quad \text{‘leave it!’}
\text{Sonority:} \quad 6.1 \rightarrow \text{slope} = -5

(10) \[
\begin{array}{ccc}
\text{/kan.ta/} & \text{IDENT[F]} & \star \text{DIST} -5 \\
\Rightarrow \text{kan.ta} & * & * \\
\text{kal.ta} & *! & \\
\end{array}
\]

4 The *DISTANCE hierarchy is formally developed through relational alignment of the *ONSET/X and *\( \mu/ \text{X} \) hierarchies; this produces a syllable-contact hierarchy which may also be characterized in terms of numeric sonority contours.
*DIST -4 » IDENT[F]: Clusters with a drop of -4 (e.g. r.ŋ) never surface faithfully.

<table>
<thead>
<tr>
<th></th>
<th>*DIST -4</th>
<th>IDENT[F]</th>
<th>*DIST -5</th>
</tr>
</thead>
<tbody>
<tr>
<td>tar.ŋa</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ tar.ka</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

The ranking in (8), *DIST -4 » IDENT[F] » *DIST -5, predicts the absence of lateral-final clusters.

<table>
<thead>
<tr>
<th></th>
<th>*DIST -2</th>
<th>*DIST -4</th>
<th>IDENT[F]</th>
<th>*DIST -5</th>
</tr>
</thead>
<tbody>
<tr>
<td>taw.la</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>➔ taw.ta</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

2.3. Interim summary

Australian languages commonly ban laterals word-initially and postconsonantally.

These restrictions can be explained in terms of the relatively high sonority of laterals.

Such an analysis correctly predicts other phonotactic patterns in Australian languages.

3. Alternative: Licensing by Cue

Licensing by Cue (LBC) would explain lateral phonotactics in terms of the interaction of lateral acoustics and contextual acoustics (Steriade 1997, 1999).

LBC has been applied to the phonotactics of retroflex segments.

Cross-linguistically, retroflexion is implicationally licensed: V_ > #_ > C_

Retroflexes differ from apico-alveolars in their left-edge F3, F4 transitions (Steriade 1999; Stevens and Blumstein 1975); this makes them acoustically left-anchored.

A segment’s left-edge environment renders its left-edge cues more or less perceptable.

LBC analyses claim that the presence of asymmetrical segmental cues determines possible patterns of segmental phonotactics.

Observation: Laterals have the same V_ > #_ > C_ implicational distribution as retroflexes.

Experimental question: Are laterals, like retroflexes, acoustically left-anchored?

Result: There is no evidence of left anchoring in laterals.
3.1. Methods

Recordings from three Australian languages where lateral manner of articulation has an implicational V_ > #_ > C_ distribution.\(^5\)

\begin{itemize}
  \item a. **Ngandi**  (Arnhem Land; Heath 1978)
    
    Laterals: l \(\backslash l\)
    
    Word-initial: l \(*l\)
    
    Postconsonantal: l \(*l\)
  \item b. **Jingulu**  (Mindi; Pensalfini 1997)
    
    Laterals: l \(\backslash \acute{\alpha}\)
    
    Word-initial: l \(*l\ \backslash \acute{\alpha}\)
    
    Postconsonantal: \(*l\ \backslash \acute{\alpha}\)
  \item c. **Warlpiri**  (Pama-Nyungan; Nash 1986)
    
    Laterals: l \(\backslash \acute{\alpha}\)
    
    Word-initial: l \(*l\ \backslash \acute{\alpha}\)
    
    Postconsonantal: \(*l\ \backslash \acute{\alpha}\)
\end{itemize}

(Retroflex and palatal laterals are sometimes subject to independent restrictions, e.g. LBC, in particular phonotactic positions.)

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{[ala], from Jingulu *kala*}
\end{figure}

Likely locus of acoustic asymmetry:

Formant transitions: **NO** – transitions appear basically symmetrical (unlike retroflexes).

Stevens (1998: 550) reports long anticipatory F2 transitions in English laterals; these are not present in Australian laterals.

Overall spectral intensity: **YES** – laterals are less intense than vowels.

The mouth is relatively closed and the supralingual cavity causes an acoustic zero.

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Procedure:

Available tokens of laterals in each language, pronounced by a single speaker, in the context \textit{a\_a}, were selected.

- **Ngandi**: 10 \( \lambda \), 14 l
- **Jingulu**: 5 \( \lambda \), 9 l, 8 l
- **Warlpiri**: 15 \( \lambda \), 13 l, 12 l

Edges of each lateral and flanking vowels were identified by hand.

Spectral amplitude measures in each lateral were taken (in Praat; Boersma and Weeninck 1992) at the midpoints of the glottal pulses which include the following positions:
- Midpoint of preceding and following vowels
- Midpoint of lateral
- Last three pulses in preceding vowel; first and last three pulses in lateral; first three pulses in following vowel

Amplitude measurements were normalized as follows:
- The intensity of the preceding vowel was subtracted from the intensity at points temporally preceding the lateral midpoint.
- The intensity of the following vowel was subtracted from the intensity at points following the lateral midpoint; this normalization to the nearest flanking vowel was intended to compensate for differences in e.g. the location of stress relative to the lateral.
- The intensity of the lateral midpoint was compared to the intensity at the midpoints of both preceding and following vowels, to evaluate relative coarticulation.

**Predictions**: If laterals are left-anchored,

…preceding vowels should be less intense (more coarticulated with laterals) than following vowels

\textit{AND/OR}

…vowel \( \rightarrow \) lateral transitions should be less intense (more lateral-like) than lateral \( \rightarrow \) vowel transitions.
3.2. Results

Preceding vowels are NOT more coarticulated with laterals than following vowels.

![Figure 2](image)

Figure 2. Flanking vowel coarticulation with laterals, measured as difference between the normalized intensity of laterals and preceding/following vowels; low values indicate high coarticulation. Data is averaged across Ngandi, Jingulu, and Warlpiri laterals at each place of articulation, with 95% CI.

Except for possibly in retroflexes, which are known to be independently left-anchored, laterals do not induce asymmetrical coarticulation in preceding vowels.
Anticipatory transitions are NOT more characteristically lateral than following transitions.

Does the end of the pre-lateral vowel look characteristically lateral? NO.

Figure 3. Normalized intensity across lateral edge transitions. Data points are at the midpoints of the three glottal pulses immediately preceding and following each edge of the lateral. Horizontal lines represent the intensity at the midpoints of each flanking vowel. Vertical lines represent lateral edges. Data is averaged across Ngandi, Jingulu, and Warlpiri laterals at each place of articulation, with 95% CI.

Conclusion: There is no evidence that laterals are left-anchored. LBC cannot explain their phonotactic distribution in terms of their acoustic properties.
3.3. Discussion

Given the acoustic data above, where would LBC predict that laterals should appear?

Figure 2: Following vowels may be more coarticulated with laterals than preceding vowels.

→ There may be more characteristics of laterality in a following vowel.

→ LATERALS MAY BE RIGHT-ANCHORED.

Figure 3: A brief, burst-like amplitude peak (relative to mid-vowel amplitude) follows a lateral.

Abrupt acoustic events play a crucial role in segment identification. (Blumstein and Stevens 1979, 1980; Stevens and Blumstein 1978)

→ More information about laterality seems to be available in a following vowel.

→ LATERALS APPEAR TO BE RIGHT-ANCHORED.

Laterals are **phonotactically left-anchored**, but are if anything **acoustically right-anchored**.

LBC (strong): Asymmetrical segmental acoustics determine segmental phonotactics. Edge-sensitive segmental phonotactics are the result of asymmetrical acoustics.

These claims are **NOT SUPPORTED** by lateral acoustics.

LBC (weak): Asymmetrical segmental acoustics **may** determine segmental phonotactics (as for retroflex segments), but other factors may also be important (as for laterals).

4. Conclusion

The left-edge environment of a phonotactic position determines whether laterals are licensed.

Lateral acoustics:
- Show no evidence of left-anchoring.
- May show phonotactically unexpected evidence of right-anchoring.

Optimality-theoretic positional sonority restrictions:
- Correctly describe lateral phonotactics.
- Correctly predict other phonotactic patterns.

A sonority-based analysis is the best way to describe lateral phonotactics.
References


