THE PHONETICS AND PHONOLOGY OF
RHOTIC DURATION CONTRAST AND NEUTRALIZATION

A Thesis in
Spanish
by
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ABSTRACT

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A number of the world's languages exhibit a phonological duration-based contrast between an extra-short coronal tap and a sustainable multiple-cycle trill. The post-SPE generative literature has focused almost entirely on the distribution of rhotics in Iberian Romance, and Spanish in particular. The main empirical goal of this dissertation is to demonstrate how Iberian Romance fits in among a broader typology of rhotic patterns. Relevant data from Spanish, Catalan, European Portuguese, Basque, Sebei, Kali-Kove, Kairiru, Palauan, Kurdish, and Ngizim suggest an implicational hierarchy of the form intervocalic < word-initial < elsewhere (word-final, pre- and postconsonantal), where rhotic duration contrast in a given position entails contrast in positions to the left. Further generalizations are uncovered with respect to patterns of neutralization. The theoretical goal of this dissertation is to develop a comprehensive analysis of the complete rhotic duration typology.

Chapter 1 introduces the analytical framework of phonetically-based Optimality Theory, focusing specifically on Correspondence Theory, the Dispersion Theory of
contrast, Segmental Autonomy, and Licensing by Cue, and then gives a preview of the proposed analysis.

Chapter 2 demonstrates how contemporary generative accounts have consistently invoked syllable structure and/or sonority in attempts to explain the distribution of the tap and trill in Spanish. Data are then presented from languages beyond Spanish in order to show that not all aspects of the behavior of these rhotics can be adequately captured with reference to syllable structure alone, thereby setting the stage for the phonetically-based Optimality-theoretic analysis.

Chapter 3 develops an account of the rhotic duration typology, with Spanish serving as the primary example. On this account, phonetic and phonological constraints interact directly to determine the surface distribution of rhotics without reference to syllable boundaries. Since reference to syllable structure is unnecessary, the analysis does not face the same difficulties as existing prosodic accounts when data beyond Spanish are taken into consideration.

Chapter 4 presents an empirical survey of languages beyond the Iberian Romance family and documents several heretofore unnoticed generalizations regarding the positional neutralization of rhotic duration contrast. These generalizations are then shown to follow straightforwardly as a consequence of constraint interaction under the phonetically-based OT analysis developed in Chapter 3.

Finally, Chapter 5 treats issues of phonological representation by focusing on the ambiguous nature of the surface trill, which patterns sometimes as a single unit and sometimes as a cluster of taps. Specifically, it is argued that a morphologically-derived
sequence of taps is neutralized to trill by dint of a targeted constraint enforcing
goalescence of adjacent rhotics. Chapter 5 concludes by summarizing the main results of
the dissertation and by outlining some issues for future research.
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Chapter 1

Introduction

Rhotics are known for the considerable phonetic variety they exhibit across languages and dialects. While most of the world's languages contain at least one rhotic phoneme, some languages have more than one, usually contrastive in type rather than place (Ladefoged and Maddieson 1996:237). A number of languages oppose two rhotic phonemes exclusively on the basis of duration: an extra-short coronal tap versus a sustainable multiple-cycle trill. These languages differ with respect to the environments in which rhotic duration contrast is maintained, and further differences are found in patterns of neutralization. It is precisely this area of the phonology of rhotics—duration-based contrast and neutralization—that forms the topic of this dissertation.

Since SPE (Chomsky and Halle 1968), the generative literature has devoted much attention to rhotics in Iberian Romance, and Spanish in particular. The common property of all Spanish varieties is that two rhotics are in contrast only in intervocalic position within the word, while contrast is neutralized in all other positions. The trill occurs word-initially and after alveolar consonants. The tap occurs in other positions, but may be realized postlexically as a trill in emphatic or careful speech. Contemporary accounts of the intervocalic contrast have analyzed the trill either as a separate phoneme or as the geminate counterpart of the singleton tap. Syllable structure and sonority principles have also played important roles in accounting of the allophonic distribution of rhotics in positions of neutralization. Most recently, however, Bonet and Mascaró (1997)
acknowledge that by limiting their analytical focus to the basic distribution of rhotics in Iberian Romance, they necessarily leave aside relevant facts from other languages "which have a somewhat different pattern, but which should be taken into consideration within a more comprehensive account of the phonology of rhotics" (103). The main empirical goal of this dissertation is to demonstrate how Iberian Romance fits in among a broader typology of rhotic patterns.

1.1 A Typology of Rhotic Duration Contrast and Neutralization

On the basis of facts emerging from a comprehensive survey of languages with contrastive tap and trill, it will be argued that general Spanish pattern is merely one of three major phonotactic possibilities with respect to positions of contrast preservation. Table 1–1 illustrates positions of word-level contrast and neutralization in the languages of the typological survey carried out in Chapter 3.¹

¹ Several language varieties with two contrastive rhotics must be excluded from the typology of Table 1–1 because duration is not the relevant dimension of contrast. For instance, most varieties of European and Brazilian Portuguese contrast an alveolar tap and an uvular rhotic, with various phonetic manifestations in the latter, e.g., a voiced trill [ʁ], a voiced fricative [ʢ], and a voiceless fricative [χ̚]. Similarly, the alveolar trill of general Spanish is realized with distinct manner and place specifications in some dialects, e.g., the prepalatal sibilant of Andean Spanish and other varieties, and the voiceless velar fricative of Caribbean varieties (see Lipski 1994). Beyond the Iberian Romance family, at least two languages have been reported to have a tap/trill contrast between vowels and word-initially: Guajiro (Mansen 1967) and Malayalam (Kumari 1973). Subsequent research suggests, however, that in both languages, the relevant contrast is one not of duration but of manner and/or place. Guajiro contrasts a lateral flap with an alveolar trill (Alvarez 1986). In Malayalam, one rhotic is a palatalized dental, while the other is an uvularized alveolar (McAlpin 1998). Like the Portuguese and Spanish varieties, Guajiro
Table 1–1: A typology of word-level rhotic duration contrast and neutralization

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<tr>
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<td>Basque</td>
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<tr>
<td>Iberian Romance</td>
<td>contrast</td>
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<td>tap/trill</td>
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<tr>
<td>Sebei</td>
<td>contrast</td>
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<td>Kaliai-Kove</td>
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<td>Palauan</td>
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</table>

The typology in Table 1–1 suggests several generalizations regarding patterns of rhotic duration contrast and neutralization. First, languages with tap and trill appear to be situated along a continuum of positional contrast maintenance. There is an implicational relation among contrastive positions, as illustrated by the hierarchy in (1.1):

\[
(1.1) \quad \text{Position 1} \quad < \quad \text{Position 2} \quad < \quad \text{Position 3}
\]

where contrast in Position x entails contrast in Position y iff y < x.

If rhotic duration contrast is maintained in a given position within the hierarchy in (1.1), then contrast is also maintained in positions to the left. An obvious exception is Kurdish, in which the tap and trill contrast in Positions 1 and 3 but not in Position 2, where the trill

and Malayalam will not be dealt with in this dissertation because the relevant dimension of contrast is not exclusively duration.

2 "Iberian Romance" is a label encompassing those dialects of Catalan, Spanish, and European Portuguese in which the trill is realized as an alveolar vibrant.
is obligatory. In Chapter 4, I argue that this is only an apparent exception and demonstrate how neutralization to trill in word-initial position makes the Kurdish system \textit{harmonically incomplete} in the sense of Prince and Smolensky (1993:185).

Table 1–1 also documents several generalizations regarding neutralization, which are summarized in (1.2):

(1.2) a. Neutralization affects other positions within the word before it affects intervocalic position. Contrast is maintained between vowels in all of the languages surveyed.

b. In most of the languages surveyed, word-initial position either maintains contrast or exhibits neutralization to trill.

c. Word-initial tap entails taps also in heterorganic clusters and word-finally, as shown in Sebei. In contrast, word-initial trill does not entail obligatory trills in heterorganic clusters nor word-finally. This is demonstrated by Iberian Romance and Kurdish, in which the trill surfaces word-initially, while both the tap and trill surface in heterorganic clusters and word-finally—non-contrastively in Iberian Romance versus contrastively Kurdish.

d. Neutralization treats word-final position and heterorganic clusters as a natural class. No language neutralizes contrast in heterorganic clusters without also neutralizing it in word-final position, and vice-versa.

e. Rhotics do not cluster with homorganic consonants in six of the languages surveyed. In the remaining languages, the trill is obligatory under several types of coronal-adjacent configurations. Contrast is never allowed in homorganic clusters in any of the languages surveyed.

Since existing accounts have not considered languages beyond the Iberian Romance family, a comprehensive explanation for the above generalizations has yet to be developed. In Chapter 2, I present data from other languages of the typology that raise problems for previous syllable-based accounts of Spanish rhotics. I show that not all
aspects of the behavior of rhotics can be adequately captured with reference to syllable structure alone.

1.2 Theoretical Background and Assumptions

The theoretical goal of this dissertation is to develop a comprehensive analysis of the attested cross-linguistic patterns of rhotic duration contrast and neutralization shown in Table 1–1. The analysis is couched within the constraint-based framework of Optimality Theory (OT; Prince and Smolensky 1993, McCarthy and Prince 1993a,b, 1995). Specifically, I argue that the observed typological patterns reflect distinct grammars, each predicted by different possible rankings of constraints on rhotic duration contrast and neutralization. Drawing upon the recent work of Flemming (1995), Kirchner (1997, 1998), and Steriade (1995a, 1997, 1999a, 2001a,b), I assume a version of OT in which phonetic and phonological constraints interact directly to determine the surface distribution of features without reference to syllable boundaries. Since reference to syllable structure is unnecessary, the analysis developed here does not face the same difficulties as existing syllable-based accounts when data beyond general Spanish are taken into account.

With respect to the phonotactics of the tap and trill, important aspects of the present analysis are the following:
(1.3) Relevance of theoretical proposals to the analysis of rhotic duration contrast and neutralization

a. **Optimality Theory** (Prince and Smolensky 1993; McCarthy and Prince 1993a,b, 1995)
Rhotic patterns are expressed in terms of ranked and violable constraints that apply in parallel.

b. **Dispersion Theory** (Flemming 1995)
Rhotic duration contrast is enforced directly in the surface representation without the need for underlying representation.

c. **Segmental Autonomy** (Steriade 1999a, 2001a)
Phonotactic restrictions on the distribution of rhotics are formulated in strictly linear terms without reference to syllable boundaries.

d. **Licensing by Cue** (Steriade 1995a, 1997, 1999a, 2001a,b)
The likelihood of rhotic duration contrast in a given context is a function of the relative perceptibility of the contrast in that context.

The following sections introduce relevant theoretical background by discussing each of the proposals in (1.3), beginning with the Optimality Theory framework. Section 1.3 then gives a preview of the analysis to be developed in subsequent chapters. Finally, Section 1.4 presents an overview of the dissertation.

### 1.2.1 Optimality Theory

Standard OT (Prince and Smolensky 1993; McCarthy and Prince 1993a,b) provides a framework for analysis in which ranked and violable constraints apply in parallel to determine the optimal mapping between input and output forms. This approach contrasts with derivational models in which ordered rules apply to yield a series of intermediate representations between input and output. In OT, two functions determine the optimal input-output mapping: GEN, which generates output candidates, and H-EVAL, which
selects the output candidate which best satisfies the constraints. The structure of an OT
grammar is shown in (1.4):

(1.4 ) Structure of an OT grammar (Prince and Smolensky 1993:4)

a. GEN (Input\(k\)) \rightarrow \{Output\(_1\), Output\(_2\)\ldots\}

b. H-EVAL (Output\(i\), \(1 \leq i \leq \infty\)) \rightarrow \text{Output}_{\text{real}}

According to the Richness of the Base (ROTB) hypothesis (Prince and Smolensky
1993; see also Itô, Mester, and Padgett 1993, 1995; Kirchner 1995, 1997; Smolensky
1996, inter alia), there are no restrictions placed on input representations. Rather, output
forms must be determined by the particular constraint ranking of the language in
question. As Smolensky (1996) argues,

"[t]he source of all systematic cross-linguistic variation is constraint
reranking. In particular, the set of inputs to the grammars of all languages
is the same. The grammatical inventories of a language are the outputs
which emerge from the grammar when it is fed the universal set of all
possible inputs" (3).

The implication of the ROTB hypothesis is that all possible inputs must be dealt with in a
given analysis. It is insufficient to stipulate that a certain segment or feature value does or
does not belong in the phonological inventory of some language. Rather, the
phonological behavior of segments and features must be shown to follow from the
constraint system of that language.

Output candidates are evaluated in terms of their violations of the ranked
constraints. Evaluations are shown in the form of a tableau:
Input-output mappings are evaluated against constraints in an OT tableau

<table>
<thead>
<tr>
<th>Input_ _</th>
<th>CONSTRAINT A</th>
<th>CONSTRAINT B</th>
<th>CONSTRAINT C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output_1</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≠ Output_2</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Output_3</td>
<td></td>
<td></td>
<td>**!</td>
</tr>
</tbody>
</table>

The input appears in the first cell of the tableau, while output candidates are shown below in the same column. Constraints are given along the top of the remaining columns. A crucial ranking between two constraints is indicated by a solid line separating the two columns. For example, tableau (1.5) represents a language in which three hypothetical constraints are ranked as follows: CONSTRAINT A \( \gg \) CONSTRAINT B, CONSTRAINT C. That is, CONSTRAINT A outranks CONSTRAINT B, but CONSTRAINT B is unranked with respect to CONSTRAINT C. A constraint violation is indicated by an asterisk. If a violation causes an output candidate to be eliminated from the evaluation, then that violation is said to be fatal, and the symbol '!' appears next to the relevant asterisk. The symbol '≠' marks the winning output candidate (i.e., the candidate that remains after all others are eliminated). Cells are shaded to indicate that any violations which they may contain are irrelevant to the evaluation.

As an illustration, let us consider the evaluation shown in tableau (1.5). Output_1 violates CONSTRAINT A, which is top-ranked. Since there are other candidates that do not violate this constraint, Output_1 is eliminated from consideration, and the lower-ranked constraints are now irrelevant to this candidate, as indicated by the shaded cells. None of the remaining candidates violates CONSTRAINT B. With respect to CONSTRAINT C, however, Output_2 incurs a single violation, while Output_3 incurs two violations. A
candidate that multiply violates some constraint loses to any candidate that violates the same constraint to a lesser degree. The second violation of CONSTRAINT C by Output₃ is a fatal one, and Output₂ is selected as the winner.

To summarize, OT provides a framework in which phonological systems are expressed in terms the ranked and violable constraints. Grammars consist of "a set of highly general constraints which, through ranking, interact to produce the elaborate particularity of individual languages" (Prince and Smolensky 1993:198). See Prince and Smolensky (1993) for a more detailed presentation of this formalism.

1.2.2 Evolving Conceptions of Phonological Contrastiveness

This section examines how views of phonological contrastiveness have shifted over the years from an abstract, representational model to one in which contrast is seen as an epiphenomenon of constraint ranking. The goal here is to motivate the second theoretical assumption of this dissertation: phonological contrast is enforced directly in the surface representation without the need for underlying representation.

Phonologically contrastive features have traditionally been assumed to constitute a subset of the total number of phonetic features that characterize speech sounds. Attempts to determine the proper set of phonological features have typically lead to the exclusion of those phonetic properties that never serve as the sole basis of contrast. This reductionist trend is expressed by Jakobson and Halle (1962:483), who argue that "[t]he supposed multiplicity of features proves to be largely illusory." Keating (1984) takes a similar view by criticizing proposals of Halle and Stevens (1973):
"Halle and Stevens (and SPE) don't simply have the wrong features in these instances; they will always have too many features because they want to describe exactly how individual sounds are articulated. While we want phonological features to have some phonetic basis, we also want to distinguish possible contrasts from possible differences" (289).

These assumptions reflect the representational view of phonological contrast. Underlying representation encodes contrast in an abstract manner, and non-contrastive features are generally not specified as part of the representation. Subsequently, phonological operations derive a surface representation, which is ultimately provided with rich phonetic detail by an implementation component. This model is shown in Figure 1–1.

<table>
<thead>
<tr>
<th>Underlying Representation</th>
<th>(ideally) pure representation of contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonological Component</td>
<td>non-contrastive properties may be filled in, particularly if contrastive in other languages</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonetic Component</td>
<td>remaining non-contrastive phonetic properties, including gradient values, filled in</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Phonetic Representation</td>
<td>representation of all speaker-controlled phonetic properties of the utterance</td>
</tr>
</tbody>
</table>

Figure 1–1: The standard (representational) treatment of contrastiveness (from Kirchner 1998:60)

Steriade (1995b) identifies several problems with this model. For example, the feature [sonorant] defines such an important natural class of segments that phonologists have typically assumed it to be present at the earliest derivational stages, despite the fact that its value is predictable in nasal segments, oral stops, and vowels. Similarly, syllable
structure is considered to play a fundamental role in the derivation, yet it is never contrastive per se in any language. According to the model of contrastiveness in *Figure 1–1*, the feature [sonorant] and syllable structure should be absent from deep derivational levels, since the former is predictable and the latter is never contrastive. Another criticism stems from the fact that some feature contrasts are licensed in certain positions but not others. While representational restrictions may be invoked to explain the lack of contrast, so may neutralization rules or constraints. The availability of both analytical approaches to positional neutralization constitutes a redundancy in the theory.3

Kirchner (1997, 1998) proposes to abandon the representational model by shifting the burden of contrast onto the constraint system. Specifically, contrastiveness is argued to be an epiphenomenon of the interaction between markedness and faithfulness constraints in the OT sense, without resorting to the representational and derivational assumptions of the standard model shown in *Figure 1–1*. As Kirchner argues, one of the benefits of assuming the ROTB hypothesis is that phonological representations are free to include non-contrastive aspects of phonetic detail, such as duration or consonantal release. Such a move allows phonetic explanations for phonological patterns to be captured directly. The following section shows how Correspondence Theory (McCarthy and Prince 1995) permits an account of phonological contrastiveness in terms of constraint ranking.

3 See Kirchner (1998:60-62) for further criticism of the representational model of contrastiveness.
1.2.2.1 Correspondence Theory

In Correspondence Theory (McCarthy and Prince 1995), constraints assess correspondence and identity of correspondent elements between phonological strings. For example, the constraint on featural correspondence in (1.6) strives to maintain identical specifications between two strings with respect to some feature F. The constraint in (1.7) is a specific instantiation of (1.6) that regulates input and output strings:

\begin{align*}
(1.6) & \quad \text{\textsc{IDENT}(F)} \\
& \quad \text{Let } \alpha \text{ be a segment in } S_1 \text{ and } \beta \text{ be any correspondent of } \alpha \text{ in } S_2. \\
& \quad \text{If } \alpha = [\gamma F], \text{ then } \beta = [\gamma F]. \\
& \quad \text{(Correspondent segments are identical in feature } F). \\
(1.7) & \quad \text{\textsc{IDENT–IO}(F)} \\
& \quad \text{Output correspondents of an input } [\gamma F] \text{ segment are also } [\gamma F].
\end{align*}

The faithfulness constraint \textsc{IDENT–IO}(F) ensures that underlying specifications for some feature F will surface faithfully in the output. Input-output correspondence thus has a fundamental role in OT, namely that of ensuring contrast.\(^4\) Specifically, a feature F is contrastive in a grammar if there is an input-output correspondence constraint on F that outranks markedness constraints on the surface distribution of some value of F. Two separate tableaux are required to fully demonstrate F contrast, one for each underlying F value:

\(^{4}\) Correspondence Theory has supplanted the earlier containment-based faithfulness constraints \textsc{PARSE} and \textsc{FILL} (McCarthy and Prince 1993a, Prince and Smolensky 1993).
(1.8)  High-ranking IDENT–IO(F) ensures recovery of underlying F contrast

<table>
<thead>
<tr>
<th>/+F/</th>
<th>IDENT–IO(F)</th>
<th>*[+F]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+F]</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>[-F]</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>/–F/</th>
<th>IDENT–IO(F)</th>
<th>*[+F]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+F]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>[-F]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In each tableau above, high-ranking IDENT–IO(F) gives a fatal violation mark to the output candidate whose F value differs from the input value. Input-output correspondence thus ensures that output values for F are identical to the input values.

On the other hand, if markedness constraints against F values outrank IDENT–IO(F), then the feature F is not contrastive, regardless of input specifications. This is demonstrated by the tableaux in (1.9):

(1.9)  Low-ranking IDENT–IO(F) ensures that F is not contrastive

<table>
<thead>
<tr>
<th>/+F/</th>
<th>*[+F]</th>
<th>IDENT–IO(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+F]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>[–F]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>/–F/</th>
<th>*[+F]</th>
<th>IDENT–IO(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+F]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>[–F]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since markedness against [+F] always ensures [–F] in the output, input specifications of F are irrelevant. There can be no surface F contrast under this ranking because it is impossible for underlying /+F/ to surface faithfully.

In sum, the contrastiveness of a particular feature depends on the relative ranking of correspondence and markedness constraints relevant to that feature. On this view, it is no longer necessary to impose restrictions on underlying representation. *Figure 1–2* illustrates this model of phonological contrast:
Since there are no restrictions on the input in this model, aspects of phonetic detail need not be excluded from underlying representations. The feature F appearing in the hypothetical tableaux (1.8) and (1.9) could plausibly refer to non-contrastive phonetic categories such as [extra-short closure] or [release], which would be excluded under the representational model of phonological contrast in Figure 1–1. Since contrastiveness of a given feature is determined independently by the constraint system, phonetic detail can play a direct role in the phonology without the threat of overgenerating spurious contrasts.

1.2.2.2 Dispersion Theory

Flemming (1995) proposes to eliminate input-output correspondence and underlying representations from the theory by appealing to constraints that demand contrast directly in the output. Working from the Theory of Adaptive Dispersion of Lindblom (1986, 1990) and others, Flemming develops constraint-based Dispersion Theory in order to
account for the language-specific selection of contrastive sound categories. According to the theory, inventory selection involves striking a balance among three goals:

(1.10) Three goals in the selection of contrasts

a. Maximize the number of contrasts.
b. Maximize the distinctiveness of contrasts.
c. Minimize effort.

Goals (1.10a) and (1.10b) are inherently conflicting. Since contrasting categories share perceptual space along some auditory dimension, fitting more contrasts into that space implies that those contrasts cannot be as distinct as a smaller set. However, when there is only one contrast between two sound categories, goal (1.10b) is no longer at issue because there are no other contrasts from which the existing one must be kept perceptually distinct. This is the case of rhotic duration contrast, in which there is a single contrast between the coronal tap and trill. For present purposes, I conflate (1.10a) and (1.10b) into a single CONTRAST(F) constraint, which seeks to maintain a surface contrast in some feature F:

(1.11) CONTRAST(F)
Maintain a surface contrast in $[\alpha F]$ with sufficient perceptual distance.

This view of contrastiveness allows consideration of surface forms alone and requires no reference to underlying representation. Lexical entries correspond to surface representations, which are themselves determined by the constraint system. Since CONTRAST(F) does not refer to input forms, one tableau is sufficient to demonstrate contrastiveness (cf. (1.8), where two tableaux are required under input-output correspondence). The collapse of two tableaux into one is more than a simple expository
convenience. Rather, it follows from the fact that Dispersion Theory enforces phonological contrast directly among surface forms, while input-output correspondence requires reference to input forms.

Now, when CONTRAST(F) outranks markedness constraints on the surface distribution of F values, the result is maintenance of a surface F contrast.

(1.12) High-ranking CONTRAST(F) demands F contrast directly in the output

<table>
<thead>
<tr>
<th></th>
<th>CONSTRAT(F)</th>
<th>*[+F]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+F] ≠ [-F]</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>[+F]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>[-F]</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

The winning candidate in (1.12) maintains two distinct surface values for F, as indicated by the ≠ symbol that intervenes between the two contrastive output specifications for [F].

CONTRAST(F) rules out candidates in which contrast is neutralized to one particular F value. When markedness constraints outrank CONTRAST(F), no contrast is possible with respect to the feature F, as demonstrated by tableau (1.13):

(1.13) Low-ranking CONTRAST(F) ensures neutralization of F contrast

<table>
<thead>
<tr>
<th></th>
<th>*[+F]</th>
<th>CONSTRAT(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+F] ≠ [-F]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>[+F]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>[-F]</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Markedness constraints such as the hypothetical *[+F] in tableau (1.12) embody the third goal in the selection of contrasts shown in (1.10c), namely that articulatory effort should be minimized.
Markedness against [+F] always ensures [–F] in the output under this ranking.
Neutralization of F contrast is guaranteed without reference to input specifications.

To sum up, Correspondence Theory permits an account of the contrastiveness of features without imposing restrictions on underlying representation. Dispersion Theory goes one step further by eliminating underlying representation altogether. In this dissertation, I adopt a surface-oriented approach to phonological contrast. I propose constraints on rhotic duration contrast which operate directly on surface representations without reference to underlying representation. Input forms are considered unnecessary and are omitted from the tableaux, as shown in (1.12) and (1.13). In Section 3.3.4.1.1 of Chapter 3, evidence is presented from restrictions on hypercorrective /s/-epenthesis in Dominican Spanish which supports surface-oriented Dispersion Theory over input-output correspondence.

1.2.3 Consonantal Phonotactics Without The Syllable

Blevins (1995:207) defines the syllable as a structural unit that organizes segmental melodies in terms of their inherent sonority. As a phonological constituent, the syllable plays a central role in contemporary phonological theory. This unit has served as an analytical tool in several empirical domains, including speaker intuitions of string division, stress assignment, and phonotactic knowledge of permissible segment sequences. In syllable-based analyses, it is often claimed that some generalization is more succinctly stated in terms of the syllable than without it. For instance, some languages appear to have phonological rules that apply at syllable edges. Without reference to the
syllable, such rules must be formulated so that they target two distinct contexts, namely
adjacent to word boundary and adjacent to a consonant. This is demonstrated by the
following schematic rules targeting consonants:

(1.14) Phonological rules that target consonants at syllable edges without reference
to syllable position

a. $\alpha \rightarrow \beta / _{\#, \text{C}}$

b. $\alpha \rightarrow \beta / \{\#, \text{C}\} _$

The problem is that boundary symbols and consonants do not form a natural class in the
structural description of the rules. The generalization missed by (1.14a) and (1.14b) is
that $\alpha$ is syllable-final in the former and syllable-initial in the latter. Reference to syllable
structure permits a more precise statement of the environments in which these rules
apply.

Despite the greater formal simplicity afforded by the syllable, recent research has
uncovered some cases in which syllable-based phonotactic statements make the wrong
predictions cross-linguistically. Steriade (1997, 1999a, 2001a) argues that this is true with
respect to patterns of voicing neutralization, aspiration, and place assimilation. In the
following sections, I examine obstruent voicing neutralization as a representative case,
beginning with a critique of constraint-based approaches that make reference to syllable
position. The reason for examining this aspect of laryngeal phonology is that it closely
parallels the case of rhotic duration contrast and neutralization. As in the domain of
obstruent voicing patterns, reference to syllable structure alone is insufficient to account
for all aspects of the behavior of rhotics.
1.2.3.1 Syllable-based Neutralization

Phonotactic restrictions govern the occurrence and combinatorial possibilities of segments or feature specifications. Restrictions on feature specifications naturally affect the distribution of contrasts involving those features. One example from the literature on laryngeal neutralization is syllable-final obstruent devoicing. In languages that have this restriction, obstruents are distinctively voiced only when followed by a vowel or sonorant. Given that prevocalic obstruents are typically syllable onsets and that obstruent-sonorant sequences are possible onset clusters, it is tempting to formalize a phonotactic statement about distinctive obstruent voicing in syllable-based terms, as in (1.15).

(1.15) Syllable-based phonotactic statements of distinctive obstruent voicing

a. A voiced obstruent is an onset. (Goldsmith 1990)

b. A voiced obstruent is followed by a tautosyllabic sonorant. (Lombardi 1995)

As Steriade (1999a) points out, constraint-based formulations of the statements in (1.15a,b) come in two flavors. In the syllabic markedness approach, context-free correspondence constraints are ranked against markedness constraints that target particular syllable positions. In the syllabic faithfulness approach, correspondence constraints are syllable-sensitive, while markedness constraints are context-free. These two approaches are exemplified by the constraint rankings in (1.16). (N.B.: Here, I adopt the surface-oriented CONTRAST(F) constraints of Dispersion Theory instead of the IDENT–IO constraints of Correspondence Theory.)
Syllable-based approaches to phonotactic restrictions on obstruent voicing

a. Syllabic markedness ranking
   *+[voi]/coda » CONTRAST(voi) » *+[voi]

b. Syllabic faithfulness ranking
   CONTRAST(voi/onset) » *+[voi] » CONTRAST(voi)

Under the syllabic markedness ranking in (1.16a), distinctive obstruent voicing is generally maintained by the ranking of CONTRAST(voi) » *+[voi], except in coda position, where [+voi] is positionally marked by the highest-ranked *+[voi]/coda constraint. The tableaux in (1.17) illustrate the effects of coda devoicing on obstruent voicing contrast, with hypothetical output forms:

(1.17) Obstruents are devoiced in coda, distinctively voiced in onset

<table>
<thead>
<tr>
<th></th>
<th>*[+voi]/coda</th>
<th>CONTRAST(voi)</th>
<th>*+[voi]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Vd] ≠ Vt]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Vd]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>Vt]</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>[dV] ≠ [tV]</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>e.</td>
<td>[dV]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>f.</td>
<td>[tV]</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

Candidate (1.17c) is optimal because it lacks a syllable-final voiced obstruent, as ensured by the high-ranking *+[voi]/coda. However, in the second tableau, the positional markedness constraint is no longer operative because the obstruent is in onset position. Therefore, the decision falls to CONTRAST(voi), which preserves distinctive voicing in the
optimal candidate (1.17d). Candidates (1.17e,f) are ruled out because [voice] is neutralized to one particular specification.

Under the syllabic faithfulness ranking in (1.16b), contrast is generally neutralized by the ranking of *[+voi] » CONTRAST(voi), except in onset position, where distinctive obstruent voicing is ensured by CONTRAST(voi/onset). The tableaux in (1.18) illustrate this, again with hypothetical output forms:

(1.18)  Obstruents are devoiced in coda, distinctively voiced in onset

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST(voi/onset)</th>
<th>*[+voi]</th>
<th>CONTRAST(voi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Vd] ≠ Vt]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Vd]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>Vt]</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>[d ≠ [t]</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>e.</td>
<td>[d]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>f.</td>
<td>[tV]</td>
<td>*!</td>
<td>*</td>
</tr>
</tbody>
</table>

In the first tableau, the context-free markedness constraint *[+voi] encodes a general ban against voiced obstruents. Neutralization to [–voi] is optimal as shown by the winning candidate (1.18c). When the obstruent is in onset position, as in the second tableau, the positional constraint CONTRAST(voi/onset) functions to preserve obstruent voicing contrast by optimizing candidate (1.18d).

Syllabic markedness and syllabic faithfulness approaches differ with respect to which type of constraint is relativized to syllabic position. Both approaches achieve the
same effect, namely that of ensuring obstruent voicing contrast in onset position while neutralizing the contrast in coda position.

### 1.2.3.2 The Segmental Autonomy Hypothesis

Steriade (1995a, 1999a) argues against syllable-based generalizations such as those in (1.15). According to the Segmental Autonomy hypothesis, reference to syllable position is unnecessary—and often insufficient—in the proper formulation of phonotactic restrictions. Rather, phonotactic statements are best understood as syllable-independent, string-based conditions reflecting positional differences in the perceptibility of contrasts. One alternative to the statements in (1.15) is to formulate the phonotactic restriction in strictly linear terms, as in (1.19):

(1.19) **Syllable-independent phonotactic statement of distinctive obstruent voicing**

A voiced obstruent is followed by a sonorant. (Steriade 1999a)

Evidence in support of the formulation in (1.19) comes from languages in which distinctive obstruent voicing is maintained before sonorants regardless of the location of syllable boundaries. The Lithuanian data in (1.20) show that coda obstruents contrast in voicing before sonorants but not before obstruents, despite the fact that the relevant clusters are heterosyllabic in each case:
Obstruent voicing contrast and neutralization in Lithuanian heterosyllabic clusters (see Steriade 1997:17–18)

a. Contrast before sonorants

sil[p.n]as 'weak' sko[b.n]is 'table'
à[t.m]inti 'to remember' liū[d.n]as 'sad'
a[k.m]uō 'stone' au[g.m]uō 'growth'

b. Neutralization before obstruents

dir[p.t]i 'work–INF'
a[d.g]al 'back'
dē[k.t]i 'burn–INF'

Obstruent voicing is phonologically contrastive before sonorants in (1.20a). However, contrast is neutralized before other obstruents, as evidenced by the uniform voicing specifications shared by the clusters in (1.20b)

The inadequacy of syllable-based approaches to the data in (1.20) is demonstrated by the tableaux in (1.21), in which the idealized output forms [p.N] and [b.N] represent the Lithuanian examples silpnas 'weak' and skobnis 'table', respectively. (N.B.: The symbol indicates that the constraints have incorrectly optimized a particular candidate.)
(1.21) Syllabic markedness and faithfulness rankings incorrectly predict neutralization before sonorants in Lithuanian

<table>
<thead>
<tr>
<th></th>
<th>*[+voi]/coda</th>
<th>CONTRAST(voi)</th>
<th>* [+voi]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. b.N ≠ p.N</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. b.N</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. p.N</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST(voi/onset)</th>
<th>* [+voi]</th>
<th>CONTRAST(voi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>d. b.N ≠ p.N</td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>e. b.N</td>
<td></td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>f. p.N</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

The positional markedness constraint *[+voi]/coda incorrectly prohibits distinctively voiced /b/ from coda position and selects candidate (1.21c) as the winner. Similarly, the positional faithfulness constraint CONTRAST(voi/onset) is irrelevant in coda position, such that context-free *[+voi] incorrectly selects candidate (1.21f) as the winner. Both approaches fail to capture a significant generalization, namely that distinctive obstruent voicing is maintained before a following sonorant regardless of the obstruent’s position within the syllable.

The existence of obstruent voicing patterns like that of Lithuanian suggests that phonotactic constraints should be formalized on the basis of linear statements like the one in (1.19). As with syllable-based accounts, one may formulate syllable-independent constraints in one of two ways, as shown in (1.22a) and (1.22b).
(1.22) Syllable-independent approaches to phonotactic restrictions on obstruent voicing

   a. Positional markedness ranking  
      *\(+\text{voi}\)/V\(_{-}\text{son}\) » CONTRAST(voi) » *\(+\text{voi}\)/V\(_{+}\text{son}\)

   b. Positional faithfulness ranking  
      CONTRAST(voi/V\(_{+}\text{son}\)) » *\(+\text{voi}\) » CONTRAST(voi/V\(_{-}\text{son}\))

Under the positional markedness ranking in (1.22a), distinctive obstruent voicing is maintained before sonorants by the ranking of context-free CONTRAST(voi) above the markedness constraint against distinctive [voice] in presonorant position. In contrast, the positional faithfulness ranking in (1.22b) preserves distinctive voicing before sonorants because the context-specific CONTRAST(voi/V\(_{+}\text{son}\)) outranks context-free markedness. The effects of these rankings are illustrated by the tableaux in (1.23):

(1.23) Positional markedness and faithfulness rankings correctly allow distinctive voicing in heterosyllabic obstruent + sonorant clusters

<table>
<thead>
<tr>
<th></th>
<th>*[+voi]/V(_{-}\text{son})</th>
<th>CONTRAST(voi)</th>
<th>*[+voi]/V(_{+}\text{son})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\not) a. b.N ≠ p.N</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. b.N</td>
<td><img src="image1.png" alt="image" /></td>
<td><img src="image2.png" alt="image" /></td>
<td><img src="image3.png" alt="image" /></td>
</tr>
<tr>
<td>c. p.N</td>
<td><img src="image4.png" alt="image" /></td>
<td><img src="image5.png" alt="image" /></td>
<td><img src="image6.png" alt="image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST(voi/V(_{+}\text{son}))</th>
<th>*[+voi]</th>
<th>CONTRAST(voi/V(_{-}\text{son}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\not) d. b.N ≠ p.N</td>
<td><img src="image7.png" alt="image" /></td>
<td><img src="image8.png" alt="image" /></td>
<td><img src="image9.png" alt="image" /></td>
</tr>
<tr>
<td>e. b.N</td>
<td><img src="image10.png" alt="image" /></td>
<td><img src="image11.png" alt="image" /></td>
<td><img src="image12.png" alt="image" /></td>
</tr>
<tr>
<td>f. p.N</td>
<td><img src="image13.png" alt="image" /></td>
<td><img src="image14.png" alt="image" /></td>
<td><img src="image15.png" alt="image" /></td>
</tr>
</tbody>
</table>

To summarize, Segmental Autonomy is the hypothesis that phonotactic constraints are independent of the location of syllable boundaries. Linear, string-based statements are necessary in order to give a full account of laryngeal neutralization.
patterns in languages like Lithuanian. The relevance of the preceding discussion of laryngeal neutralization is that in some languages, positional restrictions on rhotics must also be formulated in syllable-independent terms. In Chapter 3, we will see that both contrast and markedness constraints must be relativized to certain positions in order to account for the complete typology of rhotic patterns. In order to simplify the discussion in the remainder of this chapter, however, I will simply assume the positional faithfulness approach.

1.2.4 Constraint Hierarchies and Licensing by Cue

The positional faithfulness constraints in (1.22b) belong to a universally ranked hierarchy of constraints, shown in (1.24), all of which are formulated in accordance with Segmental Autonomy:

\[
\begin{align*}
\text{CONTRAST(voi/V}_{-}[+\text{son}]) \\
| \\
\text{CONTRAST(voi/V}_{-}[\#]) \\
| \\
\text{CONTRAST(voi/V}_{-}[–\text{son}])
\end{align*}
\]

In this section, I make two important points with respect to this universal ranking of constraints. First, the hierarchy is shown to make correct typological predictions with respect to positions of obstruent voicing contrast and neutralization. Second, the universal ranking derives from perceptibility considerations and is, therefore, motivated independently of the phonological patterns it seeks to predict.
By ranking the markedness constraint *[+voi] at various positions along the positional faithfulness hierarchy in (1.24), different patterns of [voice] neutralization are predicted to occur. These patterns are shown in (1.25), along with the rankings that generate them:

(1.25) a. Contrast before sonorants only:

\[
\begin{align*}
\text{CONTRAST}(\text{voi}/V_{\ [+\text{son}]}) \\
\rightarrow *[+\text{voi}] \\
\text{CONTRAST}(\text{voi}/V_{\ #}) \\
\text{CONTRAST}(\text{voi}/V_{\ [+\text{son}]}) \\
\end{align*}
\]

b. Contrast before sonorants and word-finally:

\[
\begin{align*}
\text{CONTRAST}(\text{voi}/V_{\ [+\text{son}]}) \\
\rightarrow \text{CONTRAST}(\text{voi}/V_{\ #}) \\
\rightarrow *[+\text{voi}] \\
\text{CONTRAST}(\text{voi}/V_{\ [+\text{son}]}) \\
\end{align*}
\]

c. Contrast before sonorants, word-finally, and before obstruents:

\[
\begin{align*}
\text{CONTRAST}(\text{voi}/V_{\ [+\text{son}]}) \\
\rightarrow \text{CONTRAST}(\text{voi}/V_{\ #}) \\
\rightarrow \text{CONTRAST}(\text{voi}/V_{\ [+\text{son}]}) \\
\rightarrow *[+\text{voi}] \\
\end{align*}
\]

As Steriade (1997) documents, the patterns in (1.25) are cross-linguistically attested. The ranking in (1.25a) accounts for Lithuanian and several other Indo-European languages, including Greek, Sanskrit, Russian, Polish, and German. The ranking in (1.25b) is
appropriate for Hungarian and Kolami, while that in (1.25c) covers Maithili, Lamani, Shilha, and various Arabic dialects.

The rankings in (1.25) express an important typological generalization: there are no grammars in which voicing is neutralized word-finally but not before obstruents. Since the ranking of CONTRAST(voi/V_#) over CONTRAST(voi/V_[–son]) is universally fixed, the ranking of *[+voi] above the former entails, by transitivity of constraint ranking, that it will also be ranked above the latter. Therefore, it is impossible for voicing neutralization to affect obstruents in word-final position without also affecting those occurring before other obstruents. This implicational asymmetry is captured directly by the positional faithfulness hierarchy.

An important question arises regarding the universal rankings of positional constraints in (1.24). Is there some independent motivation for these rankings other than the cross-linguistically attested patterns of laryngeal neutralization? In the absence of such motivation, the analysis is subject to the same accusations of circularity that are often leveled against the sonority hierarchy. Gerfen (2001) makes the following observation regarding sonority:

"Undeniably, there is a fundamental circularity in using observed patterns of segmental ordering in syllables to derive a sonority hierarchy and subsequently using the same hierarchy to explain the possible orderings of segments within syllables. This is not to say that such a hierarchy fails to make predictions about the likelihood of finding particular syllable types in natural language, but it offers little in the way of understanding why such patterns arise" (200).

In order to avoid circularity in the analysis, it is preferable to derive patterns of laryngeal neutralization from the physiological and physical properties of speech production and perception (cf. Ohala 1990, Lindblom 1990). As it turns out, the hierarchy in (1.24) is
motivated independently of the neutralization patterns it seeks to derive. Specifically, the constraint rankings are grounded in facts of contrast perceptibility.

In the Licensing by Cue framework of Steriade (1995a, 1997, 1999a, 2001a), speakers are assumed to possess knowledge of the physical conditions under which contrasts are implemented. Contrast is neutralized in positions where the relevant auditory cues are diminished, while contrast is licensed in positions where cues are perceptually salient. As Steriade (1999a) argues, "the likelihood that distinctive values of the feature F will occur in a given context is a function of the relative perceptibility of the F-contrast in that context" (4). To understand why the positional hierarchy in (1.24) is the way it is, we must examine the nature of cues to distinctive obstruent voicing in various contexts. Table 1–2 displays three segmental contexts and the cues to contrast that are potentially available there:
Table 1–2: Cues to obstruent voicing in different segmental contexts (based on Steriade 1997:6–7)

<table>
<thead>
<tr>
<th>V_ [+son]</th>
<th>V_ #</th>
<th>V_ [–son]</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOT value</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>F₀ and F₁ values at the onset of voicing in V₂</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>burst duration and amplitude</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>V₁ duration</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>F₀ and F₁ values in V₁</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>closure voicing</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>closure duration</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

The greater the number of obstruent voicing cues there are in a given context, the more perceptible the contrast is in that context.

The perceptibility scale in (1.26) encapsulates the observation that obstruent voicing contrast is most perceptible before sonorants, less perceptible in word-final position, and least perceptible before obstruents. (N.B.: The > symbol means that voicing in a given context is more perceptible than in the context listed to its right.)

(1.26) Perceptibility scale for distinctive obstruent voicing

V_ [+son] > V_ # > V_ [–son]

The speaker's knowledge of the physical conditions governing obstruent [voice] contrast can be modeled in OT using Prince and Smolensky's (1993:135) notion of harmonic alignment, whereby constraint hierarchies are aligned to harmonic scales. Specifically,
positional CONTRAST(voi) constraints are ranked in parallel with the contexts of the perceptibility scale, as demonstrated in Figure 1–3:

![Constraint hierarchy and perceptibility scale](image)

*Figure 1–3: Alignment of positional CONTRAST(voi) constraints to the perceptibility scale for distinctive obstruent voicing*

The highest-ranked CONTRAST(voi/V[+son]) constraint is aligned to the highest position on the scale, V[+son]. The procedure continues rightward until all CONTRAST(voi) constraints have been aligned to their corresponding positions on the perceptibility scale. Crucially, the universal ranking of constraints in this hierarchy is determined by perceptibility conditions. Contexts of greater perceptibility are more likely to maintain distinctive values for obstruent voicing, while contexts of diminished perceptibility are more likely to be targeted by neutralization.

1.2.5 Summary

To summarize the discussion of theoretical assumptions, Correspondence Theory has been shown to permit an account of phonological contrastiveness without imposing representational restrictions on underlying forms, as illustrated in Figure 1–2. Dispersion Theory carries the assault against underlying representation to its logical conclusion by
obviating the need for this level altogether. With respect to consonantal phonotactics, syllable-based statements do not always make the right cross-linguistic predictions. This was shown to be true with respect to obstruent voicing neutralization, which lends support to the Segmental Autonomy hypothesis that consonantal phonotactics reflect linear, string-based conditions. Finally, Licensing by Cue makes explicit the link between phonological contrastiveness and perceptibility, thereby providing an empirically superior alternative to syllable-based phonotactic accounts. The resulting organizational view of phonology—and the view assumed in this dissertation—is shown in Figure 1–4.

![Figure 1–4](image)

\[Figure 1–4:\] A phonetically-based OT model in which phonetic and phonological constraints interact directly without underlying representation (from Steriade 1997:3)

1.3 Analysis of The Rhotic Duration Typology: A Preview

In Chapter 3 of this dissertation, I develop a phonetically-based OT analysis of rhotic duration contrast and neutralization. This section previews the major constraints of the
analysis and demonstrates how typological patterns emerge as a consequence of their interaction under different rankings.

1.3.1 Contrast Maintenance Constraints

In Section 3.1 of Chapter 3, the perceptual and articulatory properties of the tap and trill are examined, and the following perceptibility scale for distinctive rhotic duration is proposed:

(1.27) \( V_\_V \succ \#_V \succ C_V, V_C, V_\# \)

Alignment of the CONTRAST constraints in (1.28a–c) to this scale results in the universal ranking shown in (1.28d):

(1.28) Constraints governing the maintenance of rhotic duration contrast

a. \( \text{CONTRAST}(\text{duration}/V_\_V) \)
   Maintain rhotic duration contrast between vowels

b. \( \text{CONTRAST}(\text{duration}/\#_V) \)
   Maintain rhotic duration contrast word-initially

c. \( \text{CONTRAST}(\text{duration}) \)
   Maintain rhotic duration contrast

d. Universal ranking
   \( \text{CONTRAST}(\text{dur}/V_\_V) \succ \text{CONTRAST}(\text{dur}/\#_V) \succ \text{CONTRAST}(\text{dur}) \)

The ranking of these constraints is motivated by positional differences in the perceptibility of distinctive rhotic duration. The contrast between the tap and trill is most perceptually salient in intervocalic position. Similarly, the perceptual prominence of word
onsets places word-initial position above all other non-intervocalic positions within the word.

Since there are separate, higher ranking constraints targeting intervocalic and word-initial positions, the remaining positions within the word are targeted by a single context-free constraint, CONTRAST(duration). An interesting prediction of this ranking is that heterorganic clusters and word-final position form the natural class of "elsewhere" contexts. This prediction is typologically accurate, as demonstrated by the implicational relationships observed among contrastive positions shown in (1.1), which I repeat here for convenience:

(1.29) Position 1 < Position 2 < Position 3

Intervocalic  Word-initial  Heterorganic clusters, Word-final

where contrast in Position x entails contrast in Position y iff y < x.

If a language maintains rhotic duration contrast in heterorganic clusters, then it will also maintain contrast word-finally, and vice-versa. The all-or-nothing nature of contrast in these "elsewhere" contexts stems from the fact that they are targeted by a single CONTRAST(duration) constraint. In the next section, I show how articulatory markedness constraints may be ranked at different positions along the hierarchy in (1.28d), thereby generating different word-level patterns of contrast and neutralization.
1.3.2 Articulatory Markedness Constraints

The principal articulatory difference between the coronal tap and trill is that the former involves a ballistic gesture consisting of rapid approach and release transitions, while the latter is a held posture upon which passive vibrations are imposed by the airstream. The analysis developed here assumes two families of markedness constraints that refer to the articulatory representation of rhotics. The *FAST constraints in (1.30a–c) below are violated by the rapid transition phases of the coronal tap, more so in homorganic clusters and in phrase-initial position, as guaranteed by the positional markedness constraints in (1.30a) and (1.30b), respectively. On the other hand, the *HOLD constraint in (1.31) is violated by the longer constriction duration of the coronal trill.

(1.30) Markedness constraints against coronal tap

a. *FAST/SAME SITE
   Avoid faster-than-usual articulatory transitions in Place-sharing clusters involving the tongue tip

b. *FAST/INITIAL
   Avoid faster-than-usual articulatory transitions in phrase-initial constrictions involving the tongue tip

c. *FAST
   Avoid faster-than-usual articulatory transitions in constrictions involving the tongue tip

(1.31) Markedness constraint against coronal trill

*HOLD
Avoid longer constrictions involving the tongue tip

In Chapter 3, I offer a more formal account of the effects that the above markedness constraints have on the articulatory realization of the tap and trill.
1.3.3 Typology of Constraint Rankings

One of the central claims of OT is that variation across languages follows from constraint ranking. Specifically, a typology of predicted grammars constitutes the set of distinct grammars predicted by different rankings of the same set of constraints. In this section, I show how the generalizations regarding neutralization in (1.2) stem from the interaction among CONTRAST(duration), *FAST, and *HOLD constraints.

First, the fact that intervocalic contrast is maintained in all of the languages surveyed stems from the dominance of CONTRAST(dur/V_V) over the markedness constraints with which it interacts, namely *FAST and *HOLD, as shown in (1.32):

\[
\text{(1.32) Constraint ranking affecting intervocalic position} \\
\text{CONTRAST(dur/V_V)} | \text{Intervocalic contrast:} \text{ in all languages surveyed} \\
*\text{FAST}, \text{ } \star \text{HOLD}
\]

While the lower-ranked constraints of the CONTRAST(dur) hierarchy may be dominated by relevant markedness constraints, the highest-ranked CONTRAST(dur/V_V) is always undominated in languages that have a contrast between the coronal tap and trill. Otherwise, there would be absolute neutralization of the contrast, and the surface realization of rhotics would be determined solely by markedness.

Second, word-initial position typically either maintains contrast or exhibits neutralization to trill. This follows from the high ranking of CONTRAST(dur/#_V) in the former case and of *FAST/INITIAL in the latter, as shown in (1.33):
(1.33) Constraint rankings affecting word-initial position

a. \textsc{Contrast}(dur/#\_V)  \hspace{1cm} \textit{Word-initial contrast:}  
\textsc{Kaliai-Kove, Palauan, Kairiru, Ngizim}  
\textsc{Fast/Initial},  
\textsc{Hold}  

b. \textsc{Fast/Initial}  \hspace{1cm} \textit{Word-initial trill:}  
\textsc{Basque, Iberian Romance, Kurdish}  
\textsc{Contrast}(dur/#\_V),  
\textsc{Hold}  

Now, when \textsc{Hold} outranks \textsc{Contrast}(dur/#\_V), it also outranks—by transitivity of constraint ranking—the context-free \textsc{Contrast}(dur), as shown in (1.34):  

(1.34) Constraint ranking affecting non-intervocalic positions

\textsc{Hold}  \hspace{1cm} \textit{Non-intervocalic tap:}  
\textsc{Sebei}  
\textsc{Contrast}(dur/#\_V),  
\textsc{Fast/Initial}  
\textsc{Contrast}(dur),  
\textsc{Fast}  

This ranking captures the third generalization regarding neutralization, namely that word-initial tap entails taps also in heterorganic clusters and word-finally. In contrast, word-initial trill does not entail obligatory trills in heterorganic clusters nor word-finally. In the ranking in (1.33b), the positional constraint \textsc{Fast/Initial} ensures word-initial trills, but

\footnote{Although the positional \textsc{Fast/Initial} is shown to dominate the context-free \textsc{Fast} in (1.34), their ranking is actually irrelevant. As long as \textsc{Hold} is dominant in the hierarchy, the effects of these two lower-ranked \textsc{Fast} constraints will not be seen. That is to say, the rankings of \textsc{Hold} \textgreater \textsc{Fast/Initial} \textgreater \textsc{Fast} and \textsc{Hold} \textgreater \textsc{Fast} \textgreater \textsc{Fast/Initial} are non-distinct in that both yield the same result, namely taps in word-initial position, in heterorganic clusters, and in word-final position.}
nothing prevents lower-ranked *FAST from interacting with the other context-free constraints *HOLD and CONTRAST(duration), thereby generating different patterns in heterorganic clusters and word-finally.

Fourth, neutralization treats word-final position and heterorganic clusters as a natural class. Three scenarios are possible for these positions, as determined by the rankings of the context-free constraints in (1.35):

(1.35) Constraint rankings affecting heterorganic clusters and word-final position

\[
\begin{align*}
\text{a.} & & \text{Contrast:} \\
& & \text{Kairiru, Kurdish, Ngizim} \\
& & \text{CONTRAST(dur)} \\
\quad & & \text{*HOLD,} \\
\quad & & \text{*FAST} \\
\text{b.} & & \text{Neutralization to tap:} \\
& & \text{Iberian Romance, Sebei, Palauan} \\
& & \text{*HOLD} \\
\quad & & \text{CONTRAST(dur),} \\
\quad & & \text{*FAST} \\
\text{c.} & & \text{Neutralization to trill:} \\
& & \text{Basque, Kaliai-Kove} \\
& & \text{*FAST} \\
\quad & & \text{CONTRAST(dur),} \\
\quad & & \text{*HOLD}
\end{align*}
\]

The facts involving neutralization in Iberian Romance are somewhat more intricate than suggested by the ranking in (1.35b). Chapter 3 examines Iberian Romance languages with alveolar trills, focusing in detail on neutralization in clusters and in word-final position.

The final generalization is that contrast is never allowed in homorganic clusters, where neutralization to trill is obligatory. This follows from the ranking of *FAST/SAME SITE above the other context-free constraints, shown in (1.36):
(1.36)  *Fast/same site \hspace{1cm} \textit{Neutralization to trill:}
\hspace{1cm} \textit{Iberian Romance, Kairiru, Ngizim}
\hspace{1cm} \textit{CONTRAST(dur),}
\hspace{1cm} *HOLD

The ranking (1.36) is assumed to hold for all the languages of the rhotic duration typology, although its effects are not visible in languages where rhotics do not surface in Place-sharing clusters.

1.4 Overview of Dissertation

In Chapter 2, I examine the distribution of rhotics in Spanish and assess previous accounts of this pattern. Data are presented from other languages in order to identify the inadequacies of existing syllable-based approaches. Chapter 3 motivates and develops the phonetically-based OT account, with Spanish serving as the primary example. In Chapter 4, I demonstrate the empirical adequacy of the analysis with respect to the other languages of the typology. Finally, Chapter 5 examines issues of representation by focusing on the ambiguous nature of the surface trill, which behaves as a single phonological unit in some languages and as a cluster in others. The final chapter then concludes the dissertation with a summary of main results and some directions for future research.
Chapter 2
Against Syllable-based Accounts of Spanish Rhotics

Contemporary generative accounts have consistently invoked syllable structure and/or sonority in attempts to explain the distribution of the tap and trill in Spanish. I present the basic distributional facts in Section 2.1 and then review previous analyses of this pattern in Section 2.2. The discussion assumes a basic knowledge of syllable structure in Spanish, as described in Harris (1983). Section 2.3 presents data from beyond Spanish in order to demonstrate that not all aspects of the behavior of rhotics can be adequately captured with reference to syllable structure alone, thereby setting the stage for the phonetically-based OT analysis to be developed and illustrated in the remainder of this dissertation.

2.1 Distribution

Two types of rhotics are found in the phonological inventory of general Spanish: a voiced alveolar tap [r] versus an alveolar trill [ɾ] (Harris 1983; Núñez Cedeño 1994). These rhotics appear in complementary distribution in all contexts within the morpheme except intervocalic, where they are phonologically contrastive, as shown in (2.1):7

7 The following symbols are used in phonetic transcriptions: periods for syllable-boundaries, double vertical lines for phrase edges (initial or final), and single vertical lines for word boundaries.
Tap and trill contrast in morpheme-internal intervocalic position

\[
\begin{align*}
\text{[ka.ro]} & \quad \text{caro} \quad \text{'dear, expensive'} & \text{[ka.ro]} & \quad \text{carro} \quad \text{'car'} \\
\text{[fo.ro]} & \quad \text{foro} \quad \text{'forum'} & \text{[fo.ro]} & \quad \text{forro} \quad \text{'lining'} \\
\text{[pe.ro]} & \quad \text{pero} \quad \text{'but'} & \text{[pe.ro]} & \quad \text{perro} \quad \text{'dog'}
\end{align*}
\]

The pairs listed in (2.1) are representative rather than exhaustive, but they suffice to demonstrate that the tap and trill surface contrastively as syllable onsets between vowels. The contrast is neutralized elsewhere, with either predictable realization or stylistically-controlled variation. The trill occurs in syllable-initial position after the sonorants /n/, /l/ and the fricative /s/, as shown in (2.2):

(a) *[on.ra] [on.ra] honra 'honor'
(b) *[al.re.de.dor] [al.re.de.dor] alrededor 'around'
(c) *[iz.ra.el] [iz.ra.el] Israel 'Israel'

Word-initial rhotics are also neutralized to trill. The examples in (2.3) show that the trill is obligatory not only after pause (a), but in any word-initial position at the phrasal level, including postconsonantal (b) and postvocalic (c):

(a) *[\|ro.sa] [\|ro.sa] Rosa 'Rose'
(b) *[konl.ro.sa] [konl.ro.sa] con Rosa 'with Rose'
(c) *[lal.ro.sa] [lal.ro.sa] la rosa 'the rose'

---

8 The alveolar fricative /s/ surfaces as [z] in coda position in (2.2c) due to regressive voicing assimilation before voiced consonants. Furthermore, in Spanish dialects that retain syllable-final /s/, /sr/ clusters may be realized as a coalesced retroflex fricative [z], e.g., Israel [izæl] (Harris 1969).
While the environments in (2.1) and (2.3c) are both intervocalic, tap/trill contrast is licensed only morpheme-internally, as in (2.1). Obligatory fortition is truly word-initial as opposed to phrase-initial in (2.3a) and syllable-initial after a consonant in (2.2).

The data in (2.4) show that the tap occurs as the second member of a complex onset, where the first member is an obstruent:

(2.4) Tap is obligatory after tautosyllabic obstruents

a. After labials
   
   [pre.sjo] *[][pre.sjo] precio 'price'
   [bra.so] *[][bra.so] brazo 'arm'
   [fri.to] *[][fri.to] frito 'fried'

b. After dentals
   
   [t res] *[][t res] tres 'three'
   [dra.ma] *[][dra.ma] drama 'drama'

c. After velars
   
   [kre.a] *[][kre.a] crea 's/he creates'
   [gri.to] *[][gri.to] grito 'scream'
   [xrus.tʃef] *[][xrus.tʃef] Jruschef 'Khrushchev'

Harris (1983) observes little dialectal variation in the realization of rhotics in onset clusters, apart from some assimilation in /t/ + rhotic clusters in some dialects. "Singers occasionally trill the r in Cr onsets for stylistic effect, but this is no more representative of normal speech than the trilling of rs in song by English speakers" (144, Fn. 14).

However, Morales-Front (1994:167) observes that the trill can surface in complex onsets

---

9 Harris (1969:52, 1983:33) singles out the foreign word Jruschef as the only instance of [xr] in Spanish.
in Spanish under conditions of highly emphatic speech (e.g., ¡inc[r]eíbles p[r]ecios! ‘incredible prices!’).\(^{10}\)

In rhyme position, the phonetic realization of rhotics is variable. The basic generalization is that the tap in casual speech alternates with the trill in highly emphatic speech before consonants and pause, as the examples in (2.5) demonstrate:

(2.5) Tap varies stylistically with trill before consonants and before pause

<table>
<thead>
<tr>
<th>Casual speech</th>
<th>Emphatic speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>[mar.(r)es]</td>
<td>~ [mar.(r)es]</td>
</tr>
<tr>
<td>[mar(r)]</td>
<td>~ [mar(r)]</td>
</tr>
</tbody>
</table>

martes 'Tuesday'
mart 'sea'

An interesting restriction on the variable realization of word-final rhotics is that when the following word begins with a vowel, neutralization to tap is obligatory. This is illustrated by the grammaticality contrasts in (2.6):

(2.6) Word-final trill is prohibited before a vowel-initial word

<table>
<thead>
<tr>
<th>Casual speech</th>
<th>Emphatic speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>[mar.(r]er(de)]</td>
<td>~ [mar.(r]er(de)]</td>
</tr>
<tr>
<td>[ma.(r]asul]</td>
<td>* [ma.(r]asul]</td>
</tr>
</tbody>
</table>

mar verde 'green sea'
mar azul 'blue sea'

Rhotics pattern asymmetrically at the edges of words. As shown in (2.3), only the trill appears word-initially, regardless of the final segment of the previous word. The data in (2.6) demonstrate that either the tap or trill may appear word-finally, unless the following word begins with a vowel, in which case the trill is disallowed.

\(^{10}\) In addition, José Hualde (personal communication) notes that some Spanish speakers in Northern Spain occasionally pronounce a trill in adconsonantal positions. This is presumably the result of language contact with Basque, in which rhotics are realized as trills in non-intervocalic positions. The rhotic pattern of Basque is analyzed in Chapter 4.
2.2 Previous Accounts

This section reviews previous accounts of Spanish rhotics. As we will see, both the intervocalic contrast and the otherwise complementary distribution of rhotics can be explained in various ways under different theoretical frameworks. The common denominator of all accounts, however, is the assumption that syllable structure plays an important role in capturing the distribution of rhotics.

2.2.1 Harris (1983)

According to Harris (1983), the tap /t/ is the only underlying rhotic of Spanish, and its alternation with the surface trill [r] is predictable, i.e., rule-governed as follows:

\[(2.7) \text{ Representations}\]
\[\text{a. Intervocalic trill: } /tr/\]
\[\text{b. All other contexts: } /t/\]

\[(2.8) \text{ Rules}\]
\[\text{a. } r \rightarrow r / X^o[\_\_]\]
\[\text{b. } r \rightarrow r / [+\text{cons}] _\_\_
\quad / \text{Rhyme}\]
\[\text{c. } r \rightarrow r \quad (\text{in emphatic speech})
\quad / \text{Rhyme}\]
\[\text{d. } r \rightarrow \emptyset / _\_ r\]

As made clear in (2.7a,b), an underlying geminate tap is posited for the intervocalic surface trill, while a single tap is posited for all other contexts. Intervocalic
contrast is thereby accounted for in terms of a singleton-geminate distinction. Evidence for the representation of the trill as an underlying cluster of taps comes from a restriction on stress assignment. Harris (1983) observes that in Spanish, when a penultimate syllable is closed by a consonant or a glide, stress cannot be assigned to the antepenultimate syllable. Accordingly, a native speaker would accept the nonce words *mulangá or *mulánga, but not *múlanga. The fact that native informants judge both nonce tamárro and tamarró to be possible but not *támarro is problematic for an analysis in which the surface trill is singly-linked to an underlying trill. This suggests the existence of an underlying heterosyllabic cluster /rt/ in which the first tap closes the penultimate syllable, thus making antepenultimate stress impossible.

The rules in (2.8) operate on underlying taps in various positions within the word, as shown in the sample derivations (2.9a–g):


<table>
<thead>
<tr>
<th></th>
<th>a.</th>
<th>b.</th>
<th>c.</th>
<th>d.</th>
<th>e.</th>
<th>f.</th>
<th>g.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UR:</td>
<td>/rosa/</td>
<td>/onra/</td>
<td>/karro/</td>
<td>/mar/</td>
<td>/mar.asul/</td>
<td>/braso/</td>
<td>/karro/</td>
</tr>
</tbody>
</table>

Lexical

<table>
<thead>
<tr>
<th></th>
<th>ro.sa</th>
<th>on.ra</th>
<th>kar.ro</th>
<th>mar</th>
<th>mar.asul</th>
<th>bra.so</th>
<th>ka.ro</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2.8a)</td>
<td>ro.sa</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(2.8b)</td>
<td>—</td>
<td>on.ra</td>
<td>kar.ro</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Postlexical

<table>
<thead>
<tr>
<th></th>
<th>—</th>
<th>—</th>
<th>—</th>
<th>mar</th>
<th>—</th>
<th>—</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2.8c)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>mar.asul</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(2.8d)</td>
<td>—</td>
<td>—</td>
<td>ka.ro</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

SR: [ro.sa] [on.ra] [ka.ro] [mar] [mar.asul] [bra.so] [ka.ro]
'rose' 'honor' 'car' 'sea' 'blue sea' 'arm' 'dear'
Once rhotics undergo word-level Syllabification, rules then apply to determine the surface realization of rhotics as a function of their prosodic position. Rule (2.8a) generates word-initial trills, as in (2.9a), while rule (2.8b) generates syllable-initial postconsonantal trills, as in (2.9b,c). Derivation (2.9c) illustrates the origin of the phonetic trill in intervocalic position: rules (2.8b,d) derive the trill from the intervocalic cluster by strengthening the second tap and subsequently deleting the first. Rule (2.8d) operates in an across-the-board fashion at the postlexical level to ensure that [rr] sequences neutralize to [r]. The fact that clusters of tap and trill do not yield distinctively longer vibrations is evidenced by pairs such as salí rápido 'I left rapidly' versus salir rápido 'to leave rapidly', which are both realized as [sa.li.ra.pi.ðo]. The expression salir rápido is never realized as *[sa.lir.ra.pi.ðo] (Harris 1983:63).

The derivation in (2.9d) shows the optional postlexical rule (2.8c) strengthening the tap in rhyme position. Another possible surface form for the derivation in (2.9d) is [mar], given that rule (2.8c) fails to apply in casual speech. The rule also fails to apply when it is bled by postlexical Resyllabification, as demonstrated in (2.9e). When the word-final tap is resyllabified as the onset of a following vowel-initial word, the structural description for rule (2.8c) is no longer met. Finally, the underlying tap surfaces unchanged in complex onsets (2.9f) and in intervocalic position (2.9g).
2.2.2 Núñez Cedeño (1988, 1994)

In Dominican Spanish, consonantal reduction in the syllable rhyme is so severe that syllable-final /s/ is arguably absent from the lexical representations of illiterate speakers (Terrell 1986). Núñez Cedeño (1988, 1994) documents a hypercorrection phenomenon in the speech of some Dominicans whereby /s/ is inserted in the syllable rhyme, yielding forms such as those in (2.10):

(2.10) Hypercorrective syllable-final [s] in Dominican Spanish (Núñez Cedeño 1988, 1994)

\[
\begin{align*}
\text{asbogado} & \quad < \text{abogado} \quad \text{'lawyer'} \\
\text{abosgado} & \quad < \text{abogado} \\
\text{abogasdo} & \quad < \text{abogados} \\
\text{bosfe} & \quad < \text{bofe} \quad \text{'lung'} \\
\text{bofes} & \quad < \text{bofe}
\end{align*}
\]

This phenomenon is observed in the speech of semi-illiterates, illiterates, and even some educated speakers. Those who pronounce syllable-final /s/ are said to speak "fisno" < fino 'refined'.

One restriction on epenthesis stems from the lack of hypercorrect forms in which [s] appears immediately before an intervocalic tap or trill, as shown in (2.11) and (2.12):

(2.11) Epenthetic [s] unattested before intervocalic tap

a. \text{caros} < \text{caro} \quad \text{'expensive; dear'}

b. \text{*casro}
(2.12) Epenthetic [s] unattested before intervocalic trill

   a. \[ \text{carresta} \quad < \text{carreta} \quad 'cart' \]

   b. \[ *\text{casrreta} \]

While \textit{caros} in (2.11a) and \textit{carresta/carretas} in (2.12a) are possible hypercorrect forms for \textit{caro} and \textit{carreta}, respectively, \*\textit{casro} in (2.11b) and \*\textit{casrreta} in (2.12b) are totally unattested.

To account for the fact that hypercorrection involves insertion of /s/ at the end of a syllable, Núñez Cedeño (1988) posits the rule in (2.13):

(2.13) /s/-epenthesis rule (Núñez Cedeño 1988:324)

\[ \emptyset \rightarrow s / _\_ \sigma \]

Epenthesis does not apply in an arbitrary manner. Rather, the process is structure-preserving, failing to apply if general syllabic or prosodic constraints would be violated. Specifically, application of the rule in (2.13) is blocked if the result would either create structures not otherwise generated by phonological rules or alter the phonological features of immediately adjacent segments.

If the forms in (2.11b) and (2.12b) are unattested because of the structure-preserving nature of the epenthesis rule in (2.13), then this is evidence in support of Harris' (1983) analysis of the intervocalic trill as an underlying heterosyllabic sequence of taps. Given the Obligatory Contour Principle (OCP; Leben 1973, 1980, Kenstowicz 1982, McCarthy 1986, Hayes 1986), which prohibits identical sequences of melodic segments, Núñez Cedeño (1988, 1994) further argues that the proper representation of the
intervocalic trill involves a one-to-many association of a single underlying tap to two timing slots, shown in (2.14):

(2.14) Geminate representation of intervocalic trill in Spanish (Núñez Cedeño 1994:24)

\[
\begin{array}{c|c}
& \\
\hline \\
C & C \\
\hline \\
\end{array}
\]

Motivation for the representation in (2.14) comes from the epenthesis-blocking facts seen in (2.12b). On the assumption that crossing of association lines is prohibited, configurations like those in (2.15) are universally ill-formed, and rules are blocked when such configurations would be derived:

(2.15) Prohibition on crossing association lines (Hayes 1986)

\[
\begin{array}{c}
* C \\
\hline \\
V \\
\hline \\
\end{array}
\]

\[
\begin{array}{c|c}
& \\
\hline \\
a & t \\
\hline \\
\end{array}
\]

Specifically, /s/-epenthesis before an intervocalic trill would violate this universal constraint on crossing association lines. The application of (2.13) in the first syllable of a word like *carreta 'cart' would yield the structure in (2.16), in which coda [s] illegally splits the heterosyllabic geminate tap:
Epenthesis before trill generates an ill-formed prosodic structure in which association lines are crossed (Núñez Cedeño 1994:31)

\[
\begin{array}{ccc}
\sigma & \sigma & \sigma \\
C & V & C & V & C & V & C & V & \sigma & \sigma
\end{array}
\]

Rule (2.13)

\[
\begin{array}{ccc}
\sigma & \sigma & \sigma \\
C & V & C & C & V & C
\end{array}
\]

Structure preservation also explains epenthesis blocking before intervocalic taps, since the result would alter the phonological features of the adjacent rhotic. The application of (2.13) in the first syllable of caro 'expensive; dear' would trigger fortition of /r/ to a trill, by the independent rule shown in (2.8b). Although not explicitly mentioned by Núñez Cedeño (1988), /s/-epenthesis must be ordered before postconsonantonal strengthening in order for the structure preservation account to go through. The derivations in (2.17) show how epenthesis triggers postconsonantonal strengthening of the adjacent tap in caro 'expensive; dear', while no such modification takes place in a word like bofe 'lung', which lacks an intervocalic tap:

Epenthesis before tap feeds postconsonantonal fortition

<table>
<thead>
<tr>
<th>UR:</th>
<th>/karo/</th>
<th>cf.</th>
<th>/bofe/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllab.</td>
<td>ka.ro</td>
<td></td>
<td>bo.fe</td>
</tr>
<tr>
<td>(2.13)</td>
<td>kas.ro</td>
<td></td>
<td>bos.fe</td>
</tr>
<tr>
<td>(2.8b)</td>
<td>kas.ro</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SR:</td>
<td>*[kas.ro]</td>
<td></td>
<td>[bos.fe]</td>
</tr>
</tbody>
</table>

11 As Eric Bakovic (personal communication) points out, there is an inherent circularity in any account that relies on structure preservation with rule ordering. For a rule to be structure-preserving, it must be ordered before other rules that it potentially affects, but then it fails to affect those rules precisely because it is structure-preserving.
On the assumption that epenthesis is a structure-preserving rule, the ill-formed prosodic structure in (2.16) and the gratuitous modification of the underlying tap induced by the application of (2.8b) both serve to block /s/-epenthesis before rhotics in intervocalic position. The lack of epenthesis in this environment suggests that the heterosyllabic cluster proposed by Harris (1983) should be represented as a one-to-many association of a single underlying /ɛ/ to two timing slots, as shown in (2.14).

One remaining problem is that it is unclear how the doubly-linked representation becomes a phonetic trill. Harris (1983) derives the trill from an underlying intervocalic cluster by rules (2.8b) and (2.8d), which strengthen the second tap and then delete the first, respectively. In the theory of Schein and Steriade (1986:693), a distinction is made between structure-dependent rules, which refer to both syllable and segmental structure, and segmental rules, which refer only to the latter. Segmental rules may affect dually-linked geminates, whereas structure-dependent rules may not.\(^\text{12}\) Since the structural description of the strengthening rule in (2.8b) refers to rhyme position, this rule is structure-dependent and, therefore, cannot apply to the segmental melody of the second C in (2.14). Although rule (2.8d) is a segmental rule and should be able to apply to geminates, it fails to apply in this case because its structural description is not met. Since rule (2.8b) cannot strengthen the second tap to a trill, rule (2.8d) is subsequently incapable of deleting the first tap. Presumably, a separate rule is required to convert the

\(^\text{12}\) Specifically, the restricted applicability of structure-dependent rules is argued to stem from the Uniform Applicability Condition (see Schein and Steriade 1986). For a related proposal of geminate inalterability, cf. the Linking Constraint of Hayes (1986).
dually-linked structure in (2.14) to a phonetic trill—in addition to the tap deletion rule
(2.8d), which is still needed to explain the reduction of postlexical tap + trill sequences.
The apparent necessity of these two redundant rules has the undesirable effect of
complicating the grammar.

2.2.3 Lipski (1990)

Lipski (1990) provides an analysis of the Spanish rhotic distribution based on syllabic
templates. Manifestation of the trill is analyzed as maximizing the syllabic template,
while the intervocalic tap is derived from a more marked underlying structure, lexically
preattached to the prosodic skeleton. Representations and rules are shown in (2.18) and
(2.19), respectively, while sample derivations are given in (2.20) below:

(2.18) Representations

a. Intervocalic tap: 
   \[
   \begin{array}{c}
   \text{V C V} \\
   \mid \\
   /r/ \\
   \end{array}
   \]
   
   b. All other contexts: 
   \[
   /r/
   \]
(2.19) Rules

a. \[ \sigma \]
\[ \emptyset \rightarrow C / O R \]
\[ C \]
\[ r \]

b. \[ \sigma \] (in emphatic speech)
\[ \emptyset \rightarrow C / R \]
\[ C \]
\[ r \]

c. \[ C C \]
\[ \rightarrow [r] \]

(2.20)  

<table>
<thead>
<tr>
<th></th>
<th>a.</th>
<th>b.</th>
<th>c.</th>
<th>d.</th>
<th>e.</th>
<th>f.</th>
<th>g.</th>
</tr>
</thead>
<tbody>
<tr>
<td>UR:</td>
<td>/rosa/</td>
<td>/onra/</td>
<td>/karor/</td>
<td>/mar/</td>
<td>/mar asul/</td>
<td>/braso/</td>
<td>/karo/</td>
</tr>
<tr>
<td>Lexical Syllab.</td>
<td>ro.sa</td>
<td>on.ra</td>
<td>ka.ro</td>
<td>mar</td>
<td>mar</td>
<td>a.sul</td>
<td>bra.so</td>
</tr>
<tr>
<td>(2.19a) rro.sa</td>
<td>on.rra</td>
<td>ka.rro</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postlexical Resyllab.</td>
<td></td>
<td></td>
<td></td>
<td>marr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2.19b) ro.sa</td>
<td>on.ra</td>
<td>ka.ro</td>
<td>mar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2.19c) ro.sa</td>
<td>on.ra</td>
<td>ka.ro</td>
<td>mar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SR: [ro.sa] [on.ra] [ka.ro] [mar] [mar|a.sul] [bra.so] [ka.ro] 
'rose' 'honor' 'car' 'sea' 'blue sea' 'arm' 'dear'

After lexical Syllabification, rule (2.19a) derives all syllable-initial trills via C-slot adjunction and subsequent autosegmental spreading of the tap, as illustrated in derivations (2.20a–c). The derivation in (2.20d) shows that optional strengthening in the syllable rhyme stems from the application of rule (2.19b) in emphatic speech. Following
the account of Harris (1983), we may also assume that emphatic strengthening is bled by postlexical Resyllabification, as shown in (2.20e). The phonetic interpretation rule (2.19c) converts the dually-linked /ɾ/ to a phonetic trill in onset and rhyme position, as seen in (2.20a–c) and (2.20d), respectively. Derivations (2.20f) and (2.20g) show how the underlying tap surfaces unchanged in complex onsets and between vowels, respectively. Crucially, lexical preattachment of the tap in the UR of (2.20g) blocks the application of rule (2.19a), on the assumption that association lines are interpreted as exhaustive (see the Linking Constraint of Hayes 1986).

The main insight of this analysis is that it captures the correlation between the duration of rhotics and their position within the syllable. In Spanish, syllabic templates permit a maximum of two elements in the onset (Harris 1986; Núñez Cedeño 1985, 1986). When the tap occurs as the second member of a complex onset, the onset contains the maximum number of elements, as shown in derivation (2.20f), and rule (2.19a) cannot apply. However, when the tap occurs as a single onset, rule (2.19a) adjoins a C-slot to the left of the slot dominating /ɾ/ because the syllable template is not already filled. On this account, word-initial and syllable-initial postconsonantal trill emerges as the default realization of rhotics in onset-initial position. Contrast this account with that of Harris (1983), which requires two separate rules: one for word-initial onsets (2.8a) and one for postconsonantal onsets (2.8b). These two processes are unified as one by rule (2.19a) under Lipski's account.

The phonological representation of rhotic contrast is another point of difference between Lipski (1990) and previous accounts. The lexically preattached structure in
(2.18a) makes the intervocalic tap the exception, in contrast to Harris’ heterosyllabic cluster in (2.7a) and to Núñez Cedeño's dually-linked geminate structure in (2.14). Lipski (1990) argues that "Spanish intervocalic [r] constitutes an idiosyncrasy, not predictable from independent principles of Spanish phonology" (164). Specifically, the tap appears intervocalically in many words in a manner not predicted by the C-slot adjunction rule in (2.19a), which blindly strengthens all syllable-initial taps. Lexical preattachment of the intervocalic tap offers a way to constrain template maximization in the onset, thereby capturing the fact that onset-initial tap is possible intervocalically but not word-initially or postconsonantally.

The template maximization approach to Spanish tap and trill is not without its potential criticisms. First, Lipski (1990) does not take into account the fact that postlexical tap + trill clusters are reduced to a single onset-initial trill. As in the case of Núñez Cedeño (1988, 1994), two redundant rules must be assumed, thereby complicating the grammar. While rule (2.19a) converts the dually-linked word-medial geminate to a single phonetic trill, a rule such as Harris' (2.8) is still necessary in order to ensure neutralization of postlexical clusters.

Second, Harris (1983) argued that the lack of proparoxytonic words with a trill in the onset of the final syllable suggests the existence of an underlying heterosyllabic geminate whose first /r/ closes the penultimate syllable, thereby precluding antepenultimate stress assignment. The same explanation is no longer possible in Lipski's account, since at no point in the derivation does the first tap of the dually-linked geminate structure close the penultimate syllable. Lipski provides a counterargument whereby the
putative restriction on antepenultimate stress in contemporary Spanish is merely a carryover from Latin:

"Latin contained some type of geminate /rr/, either heterosyllabic or ambisyllabic; the 'quantity rule' would then exclude geminate consonants from straddling the last two syllables of proparoxytones. When Spanish evolved this geminate to onset-initial [r], the original motivation for the limitation disappeared, but there was no stock of proparoxytones containing [r] in the final syllable which could enter the language under the new situation" (168).

On this interpretation, the restriction on antepenultimate stress emerges as an historical accident rather than a productive synchronic restriction. Bonet and Mascaró (1997) also eschew the heterosyllabic geminate representation and lend further evidence in support of Lipski's counterargument:

"[I]t is not at all clear why trills, which seem to attract stress, should be related to weight in this sense. If this were the case, we should also have to posit a similar type of structure for /z/, /s/ and /n/, for instance, given that these segments also 'attract stress'" (122).

These arguments may be readily assumed for other analyses positing a single underlying trill.

A final and related drawback to assuming that the trill is a tautosyllabic geminate is that the blocking hypercorrective /s/-epenthesis in Dominican Spanish cannot be explained in terms of structure preservation. As Núñez Cedeño (1994:30) points out, epenthesis should be possible before an intervocalic trill on an analysis that does not assume the heterosyllabic geminate representation, since no line-crossing violation would be produced. Lipski's analysis could be modified by having a rule of resyllabification move the initial C-slot of the dual structure into the preceding coda prior to /s/-insertion.
However, blocking of epenthesis before tap is still unexplained. Given that the strengthening rule in (2.19a) is not triggered by the presence of a preceding coda segment, insertion should be possible before intervocalic tap.

### 2.2.4 Morales-Front (1994)

Morales-Front (1994) analyzes Spanish rhotics from a constraint-based perspective, incorporating markedness constraints that refer to the prosodic position of rhotics. The difference between the tap and trill is posited to be one involving intensity of articulation, captured phonologically by the feature [ATR], or Advanced Tongue Root. Morales-Front argues that such a contrast is rare in non-rhotic consonants because a difference in tension normally has insufficient perceptibility. "Nevertheless in the case of rhotics, given that their articulation is vibrant, an increase in tension results in a distinctive increase in the number of vibrations" (Morales-Front 1994:168). On the assumption that [ATR] is unspecified when predictable from context, the underlying specifications shown in (2.21), together with the surface-constraints in (2.22), determine the phonetic realization of rhotics as tap or trill:\(^{13}\)

\[
\begin{align*}
\text{(2.21) & Representative} \\
\text{a. Tap: } & [\text{son, } \neg \text{ATR}] \\
\text{b. Trill: } & [\text{son}]
\end{align*}
\]

\(^{13}\) See Chapter 4 of Morales-Front (1994) for more on the filling-in of feature values as a function of predictability.
(2.22) Constraints

a. Align(PrWd, L, [+ATR]) (abbreviated ALIGNL)

b. Coda (abbreviated FORTITION)

\[
\begin{array}{c|c}
|x| & |
\\hline
C & \Rightarrow \ [+ATR]
\end{array}
\]

c. TENSION
[+ATR] cannot appear in a branching direct dependent of the syllable (onset or rhyme).

d. PARSE(feature)
Any feature in the input must be parsed as part of higher units.

e. Ranking:
ALIGNL, FORTITION, TENSION » PARSE(feature)

Constraint (2.22a) ensures that only the [+ATR] trill may be aligned with the left edge of the prosodic word. This constraint is equivalent to Harris' rule of word-initial fortition in (2.8a). Constraint (2.22b), which corresponds to rule (2.8b), guarantees [+ATR] in postconsonantal syllable-initial position. TENSION in (2.22c) bans the [+ATR] trill from the second position of complex onsets and from rhyme position. Finally, PARSE(feature) is a faithfulness constraint which seeks to preserve underlying values of [ATR]. In Spanish, PARSE(feature) ranks below the constraints in (2.22a–c), as shown in (2.22e). The results of this ranking are shown in the following tableaux, beginning with syllable-initial fortition in (2.23). (N.B.: In this and subsequent tableaux, the →

14 The TENSION constraint is also argued to play a role in the distribution of tense and lax vowels, which are distinguished with the feature [ATR]. See Morales-Front (1994:175–178).

15 The equivalent constraint under the Correspondence Theory (McCarthy and Prince 1995) version of faithfulness would be MAX(feature). I retain the PARSE(feature) constraint of Morales-Front's analysis for present purposes, since nothing crucial hinges on this distinction.
symbol denotes a mapping between input and output forms. This is an alternative to putting the input form in the first cell of the table.)

(2.23) Input tap strengthens to trill in word-initial and syllable-initial postconsonantal positions

<table>
<thead>
<tr>
<th></th>
<th>ALIGNL</th>
<th>FORTITION</th>
<th>PARSE(feature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>ros → ro.sa</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>ros → ro.sa</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>onra → on.ra</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>onra → on.ra</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

As shown by the input-output mappings in (2.23b,d), word-initial and syllable-initial postconsonantal taps in the input are forced to strengthen to trills by the ranking of ALIGNL and FORTITION over PARSE(feature). Since ALIGNL makes reference to the prosodic word edge, [+ATR] is ensured in any word-initial position, regardless of the final segment of the preceding word (see the data in (2.3)).

The ranking of TENSION over PARSE(feature) guarantees that only the [−ATR] tap can appear in complex onsets and in rhyme position. This is true even if the [+ATR] trill is posited in the input, as shown in (2.24a,c):

(2.24) Input trill lenites to tap in $C_2$ of complex onset and in rhyme position

<table>
<thead>
<tr>
<th></th>
<th>TENSION</th>
<th>PARSE(feature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>bras → bra.so</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>bras → bra.so</td>
<td>*!</td>
</tr>
<tr>
<td>c.</td>
<td>mar → mar</td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>mar → mar</td>
<td>*!</td>
</tr>
</tbody>
</table>
Although Morales-Front (1994) does not attempt to account for optional emphatic strengthening in the syllable rhyme, let us consider a possible approach. The appearance of both tap and trill in rhyme position and in C₂ of complex onsets means that these are positions of neutralization in which contrast gives way to stylistically-controlled free variation. If TENSION and PARSE(feature) are unranked with respect to each other, then both values of [ATR] may surface in the output.¹⁶ This is illustrated in tableau (2.25):

(2.25) Free ranking between TENSION and PARSE(feature) predicts free variation

<table>
<thead>
<tr>
<th></th>
<th>TENSION</th>
<th>PARSE(feature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>braso → bra.so</td>
<td>*</td>
</tr>
<tr>
<td>b</td>
<td>braso → bra.so</td>
<td>*</td>
</tr>
<tr>
<td>c</td>
<td>mar → mar</td>
<td>*</td>
</tr>
<tr>
<td>d</td>
<td>mar → mar</td>
<td>*</td>
</tr>
</tbody>
</table>

Since the four input-output mappings in (2.25) each receive the same number of violations, none of the output candidates is ruled out. Both the tap and trill may both occur in rhyme position or in C₂ of complex onsets, but contrast between the two rhotics is neutralized in these positions.

A shortcoming of this approach to emphatic strengthening is that it is not immediately obvious how to constrain an input trill from surfacing before a following vowel-initial word (recall the pattern illustrated in (2.6)). Under the rule-based approach

¹⁶ Recall the observation made by Morales-Front (1994:167) that trill can surface in complex onsets in Spanish under conditions of highly emphatic speech (e.g., ¡inc[r]eíbles p[r]ecios! ‘incredible prices!’). This phenomenon is not explicitly addressed in the analyses of Harris (1983) and Lipski (1990).
of Harris (1983), this restriction is accounted for via rule ordering, whereby Resyllabification bleeds optional fortition at the postlexical level. For present purposes, let us assume that phrasal Resyllabification is the result of the ONSET constraint in (2.26):

\[(2.26) \quad \text{ONSET} \]
\[
\text{Syllables must have onsets.}
\]

The problem is that nothing prevents an input trill in word-final position from surfacing in the onset of the following word, as shown in tableau (2.27):

\[(2.27) \quad \text{Word-final trill is incorrectly allowed to surface before vowel-initial word} \]

<table>
<thead>
<tr>
<th></th>
<th>ONSET</th>
<th>TENSION</th>
<th>PARSE(feature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mar asul $\rightarrow$ mar.</td>
<td>a.sul</td>
<td>$\ast$</td>
<td>$\ast$</td>
</tr>
<tr>
<td>b. mar asul $\rightarrow$ mar.</td>
<td>a.sul</td>
<td>$\ast$</td>
<td>$\ast$</td>
</tr>
<tr>
<td>c. mar asul $\rightarrow$ ma.r</td>
<td>a.sul</td>
<td></td>
<td>$\ast$</td>
</tr>
<tr>
<td>d. mar asul $\rightarrow$ ma.r</td>
<td>a.sul</td>
<td></td>
<td>$\ast$</td>
</tr>
</tbody>
</table>

ONSET rules out candidates (2.27a,b) because the initial syllable of [a.sul] 'blue' lacks an onset consonant. In candidates (2.27c,d), the word-final rhotic is resyllabified to satisfy ONSET. However, TENSION is irrelevant when the rhotic is in onset position because the constraint bans [+ATR] rhotics only from branching direct dependents of the syllable, i.e., in rhymes and in the second position of complex onsets. The decision is made by PARSE(feature), which forces input [+ATR] to surface intact. The symbol in tableau (2.27) denotes the fact that candidate (d) is incorrectly selected as the optimal output. The crucial point emerging from this discussion is that any constraint-based account attempting to capture free variation in terms of unranked constraints must be
supplemented with a mechanism to ensure obligatory neutralization to tap in word-final prevocalic contexts.

With respect to word-medial intervocalic contrast, however, lowest-ranked \textsc{parse(feature)} makes the correct prediction, as shown in tableau (2.28):

(2.28) Tap/trill contrast is maintained in intervocalic position

<table>
<thead>
<tr>
<th></th>
<th>ALIGNL</th>
<th>FORTITION</th>
<th>TENSION</th>
<th>\textsc{parse(feature)}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>karo → ka.ro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>karo → ka.ro</td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>c.</td>
<td>karo → ka.ro</td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>d.</td>
<td>karo → ka.ro</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since none of the higher-ranked constraints applies in intervocalic position, \textsc{parse(feature)} forces underlying [ATR] specifications to surface faithfully in the output.

Two final criticisms involve the resolution of postlexical rhotic clusters and the blocking of hypercorrective /s/-epenthesis in Dominican Spanish. First, Morales-Front (1994) makes no provision for a constraint ensuring the neutralization of postlexical tap + trill sequences to a single trill. Second, the analysis posits that the intervocalic trill is a single unit instead of an heterosyllabic geminate sequence. Therefore, it is not possible to explain the absence of hypercorrective [s] before trill in Dominican Spanish in terms of the structure-preservation account proposed by Núñez Cedeño (1988, 1994).
2.2.5 Bakovic (1994)

Another constraint-based account of Spanish rhotics is proposed by Bakovic (1994). Tap/trill contrast is represented in terms of Aperture Theory (Steriade 1993, 1994), which encodes stricture via three degrees of oral aperture: closure ($A_0$), release ($A_{\text{max}}$) and an intermediate aperture generating fricative turbulence ($A_\text{f}$). Following Padgett (1994), Bakovic assumes that stricture features are dominated by Place in the feature geometry, which yields the representations of tap and trill shown in (2.29). (N.B.: The $\circledR$ symbol denotes the Root node of the consonant.)

(2.29) Representations

a. Tap = rhotic approximant

\[
\begin{array}{c}
\circledR \\
[\text{cor}] \\
[\text{rho}] = [r] \\
A_{\text{max}}
\end{array}
\]

b. Trill = rhotic stop

\[
\begin{array}{c}
\circledR \\
[\text{cor}] \\
[\text{rho}] = [r] \\
A_0 \quad A_{\text{max}}
\end{array}
\]

Given the ROTB hypothesis that no restrictions may be placed on the input specifications, we must assume that either of the structures in (2.29) may be present in the input. The constraints in (2.30) determine where these structures occur in the output:
(2.30) Constraints

a. **CONTIGUITY**
The output is a contiguous parse of the input string.
b. **ALIGN(σ, L, A₀)** (abbreviated **STRONG ONSET**)
Every syllable must be left-aligned with an A₀ oral closure.
c. Ranking:
*CONTIGUITY » STRONG ONSET*

**CONTIGUITY** is a faithfulness constraint ensuring that the output is a contiguous parse of the input.¹⁷ This constraint is violated by the deletion of underlying material or by the insertion of material not present underlyingly. **STRONG ONSET** is an alignment constraint that prefers syllables to begin with A₀ oral closure. Word-initial fortition is illustrated in tableau (2.31). (N.B.: Inserted elements are indicated by the use of [ ] brackets.)

(2.31) Input tap strengthens to trill in word-initial position

<table>
<thead>
<tr>
<th></th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>/rosa/</td>
<td>A_max</td>
<td></td>
</tr>
<tr>
<td>a. ro.sa</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[A₀]A_max</td>
<td></td>
</tr>
<tr>
<td>b. ro.sa</td>
<td>A_max</td>
<td>*!</td>
</tr>
</tbody>
</table>

The input in tableau (2.31) contains a single A_max position in the word-initial onset. **STRONG ONSET** forces the insertion of an initial A₀ position, thus favoring candidate (a) over candidate (b). Candidate (a) does not violate **CONTIGUITY** because this

¹⁷ Bakovic (1994) also incorporates the faithfulness constraint **PARSE** in a more extensive analysis of the distribution of continuant and noncontinuant voiced obstruents. However, **CONTIGUITY** is sufficient for the purpose of demonstrating the analysis of rhotics.
constraint bans insertion of non-underlying elements in *string-medial* but not *string-initial* position. Since the A₀ is inserted in initial position, it does not interrupt the contiguous parse of the input string. In sum, candidate (a) is optimal because the insertion of a word-initial A₀ position permits satisfaction of STRONG ONSET without violation of CONTIGUITY.

The reason syllable-initial rhotics undergo fortition after a preceding coda nasal and lateral is that Place/stricture-sharing in this context derives the Aperture-theoretic representation of the trill in (2.29a). Consider the tableau in (2.32). (N.B.: Underparsed elements are indicated by the use of ⟨ ⟩ brackets.)

(2.32) Input tap strengthens to trill in syllable-initial position after a preceding nasal

<table>
<thead>
<tr>
<th>/on ra/</th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₀ A₀max</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| a. on.ra  |
| [cor]     |
| A₀ A₀max  |
| *!        | *          |

B.  ō ra  |
| [cor]    |
| A₀ A₀max |

The input rhotic contains a single A_max position, which surfaces in syllable-initial position in both output candidates (a) and (b). The representation of the underlying nasal as a single, unreleased A₀ closure ensures the representation of the trill shown in (2.29b),
given that the nasal + rhotic sequence shares a single [coronal] Place specification. Candidate (b) violates CONTIGUITY because the underlying nasal A₀ fails to surface in the output. (Here, I assume that the nasal A₀ position is lost but that nasality would be shifted to the previous vowel.) Candidate (a) is optimal because both the A₀ and Aₘₐₓ positions surface faithfully. CONTIGUITY is not violated by the presence of A₀ in candidate (a), since this aperture position was already present in the input.

Input sequences of /s/ followed by a rhotic, which Bakovic (1994) does not consider, turn out to be problematic under this account. Recall the data in (2.2), in which surface trill occurs in syllable-initial position after the sonorants /n/, /l/ and the fricative /s/. If we assume that the input contains a trill, then CONTIGUITY would correctly guarantee its presence in the output. However, if the input contains a tap—a logical possibility, given the ROTB hypothesis—then CONTIGUITY would forbid trill from surfacing because a nonunderlying A₀ position would have to be inserted in order to satisfy STRONG ONSET. This undesired result is shown in tableau (2.33). (N.B.: Recall that /s/ surfaces as [z] before voiced consonants due to regressive voicing assimilation.)

---

18 Bakovic (1994) speculates that the lack of Aₘₐₓ release in alveolar nasals and laterals stems from the fact that the release of air is inherent in the segment: "[nasal] indicates lowering of the velum, releasing the air through the nose. [lateral] indicates lowering of the side(s) of the tongue, releasing the air through the side(s) of the mouth" (9, Fn. 11).
(2.33) Input tap surfaces incorrectly in the output after [z]

<table>
<thead>
<tr>
<th></th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>/is rael/</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A_max</td>
<td></td>
</tr>
</tbody>
</table>

Candidate (a) is incorrectly selected as the winner, since the insertion of an A₀ in candidate (b) violates CONTIGUITY. In sum, Place/stricture-sharing does not derive the Aperture-theoretic representation of the trill in an /sr/ cluster as it does in /nr/ and /lr/ clusters.¹⁹

The CONTIGUITY constraint correctly guarantees that underlying rhotic contrast is recovered in morpheme-internal intervocalic position, as shown in tableaux (2.34) and (2.35):

---

¹⁹ Note, however, that this analysis may be on the right track with respect to those Spanish dialects in which /sr/ clusters may be realized as a coalesced retroflex fricative [z], e.g., Israel [izael] (Harris 1969). This assumes, of course, that A₀A_max constitutes a licit aperture sequence and that some provision can be made for the resulting shift in place of articulation from alveolar to retroflex.
Underlying tap surfaces faithfully in intervocalic position

<table>
<thead>
<tr>
<th></th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ka.ro</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b. ka.ro</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

As shown by the optimal candidate (2.34a), CONTIGUITY forbids the insertion of string-medial A₀, thereby forcing the input A_max to surface as such in the output. The requirement that the intervocalic onset be realized with oral closure A₀ is overridden by faithfulness in this context. CONTIGUITY fulfills a similar role when the input contains a trill, as shown in (2.35):

<table>
<thead>
<tr>
<th></th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ka.ro</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b. ka.ro</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Since the A₀ position is underparsed in (2.35b), CONTIGUITY gives this candidate a fatal violation mark and prefers the faithful candidate (a). Faithfulness guarantees that the tap and trill contrast in morpheme-internal intervocalic position.

To account for the fact that the trill is prohibited from the second position of complex onsets and from rhyme position at the word-level, Bakovic (1994) appeals to
sonority principles. An important fact regarding Spanish syllable structure is that only the liquids [l] and [r] may surface after tautosyllabic obstruents in onset position. According to Bakovic,

"...[a] possible explanation for the exclusion of [r] from this environment [i.e., complex onsets] is that it is not as sonorous, in the sense of the phonological universal sonority scale, as the liquids [l] and [r]. The constraint or interacting constraints that define possible onsets based on relative sonority in Spanish should thus be ranked high enough to exclude [r] from this position, presumably having the effect of reducing it to [r] by underparsing the posited A₀" (14).

Similarly, sonority constraints on possible coda segments must achieve the same effect, since [r] is a possible word-level coda consonant, but not [r]. For present purposes, I assume the constraint SONORITY as an expository convenience which captures that fact that the less sonorous trill is not allowed in complex onsets and in rhyme position at the word-level. If this constraint is ranked above CONTIGUITY, then the A₀ of an input trill will fail to be parsed in the appropriate environments, as illustrated in tableaux (2.36) and (2.37):

(2.36) Less sonorous trill is banned from complex onsets

<table>
<thead>
<tr>
<th>/braso/</th>
<th>SO NORITY</th>
<th>CON T IGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₀A_max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.  bra.so</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>⟨A₀⟩A_max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. bra.so</td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A₀A_max</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The input $A_0$ surfaces faithfully in candidate (2.36b), satisfying CONTIGUITY. However, higher-ranked SONORITY favors the more sonorous tap of candidate (a), in which $A_0$ is underparsed. The same ranking guarantees similar results for rhyme position:

(2.37) Less sonorous trill is banned from rhyme position

<table>
<thead>
<tr>
<th>/mar/</th>
<th>SONORITY</th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_0 A_{max}$</td>
<td>a. mar $\langle A_0 \rangle A_{max}$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. mar $\hat{A}<em>0 A</em>{max}$</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

Bakovic (1994) does not attempt to provide an account of optional emphatic strengthening in rhyme position. One possibility would be to have SONORITY unranked with respect to CONTIGUITY in emphatic speech, in a manner similar to the modification of Morales-Front's analysis pursued above (cf. the discussion surrounding (2.25)):

(2.38) Free ranking between SONORITY and CONTIGUITY predicts free variation

<table>
<thead>
<tr>
<th>/mar/</th>
<th>SONORITY</th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{A}<em>0 A</em>{max}$</td>
<td>a. mar $\langle A_0 \rangle A_{max}$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. mar $\hat{A}<em>0 A</em>{max}$</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Neither candidate in tableau (2.38) is optimal since each receives the same number of total violations. As a result, the tap may vary but not contrast with the trill in rhyme position and in $C_2$ of complex onsets.
However, the problem remains that nothing prevents an input trill from surfacing in word-final prevocalic contexts, as seen in tableau (2.39):

(2.39)  Word-final trill is incorrectly allowed to surface before vowel-initial word

<table>
<thead>
<tr>
<th>/mar asul/ \hline A_0 A_{\text{max}}</th>
<th>ONSET</th>
<th>SONORITY</th>
<th>CONTIGUITY</th>
<th>STRONG ONSET</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. mar.</td>
<td>a.sul \hline A_0 A_{\text{max}}</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. mar.</td>
<td>a.sul \hline A_0 A_{\text{max}}</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. ma.</td>
<td>a.sul \hline A_0 A_{\text{max}}</td>
<td></td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>d. ma.</td>
<td>a.sul \hline A_0 A_{\text{max}}</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Candidates (a) and (b) violate ONSET because the first syllable of [a.sul] lacks an onset consonant. In candidates (c) and (d), the word-final rhotic is resyllabified as the onset of the following vowel-initial word. Now, if the constraints abbreviated by SONORITY are relevant only to complex onsets and rhyme position, then SONORITY remains silent on the realization of syllable-initial rhotics. Therefore, the decision is made by CONTIGUITY, which incorrectly selects candidate (d) as optimal because the underlying $A_0$ surfaces faithfully in the output. This is a problem similar to that of the TENSION constraint of Morales-Front (1994) (see tableau (2.27) and the following discussion). Some additional mechanism is required to ensure neutralization to tap in word-final prevocalic contexts.

Finally, as was shown to be the case for the analysis of Morales-Front (1994), the OT account of Bakovic (1994) requires some additional constraint to handle postlexical
rhotic clusters. Similarly, the representation of the trill as a single underlying unit precludes a structure-preservation account of epenthesis blocking in Dominican Spanish.

2.2.6 Bonet and Mascaró (1997)

Bonet and Mascaró (1997) provide a sonority-based account of the distribution of the tap and trill. As shown in (2.40), they assume that the value of the feature determining the realization of underspecified /R/ as a tap or trill is generally not present underlingly, except in the case of intervocalic taps, which are marked underlingly as taps:

(2.40) Representations

a. Intervocalic tap: \[ V /r/ V \]
   \[ \mid \]
   \[ [+f] \]

b. All other contexts: /R/

This representational move is similar to Lipski's proposal in (2.18a) that intervocalic taps constitute the marked case underlingly. The core proposal of Bonet and Mascaró is that the value determining the phonetic realization of underspecified /R/ in other contexts is assigned in accordance with sonority principles. Crucially, the trill is less sonorous, ranking with obstruents, while the flap is more sonorous, ranking with glides, a shown in (2.41):

(2.41) Sonority scale (cf. Bonet and Mascaró 1997:108)

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>obstruents</td>
<td>nasals</td>
<td>laterals</td>
<td>glides</td>
<td>vowels</td>
</tr>
<tr>
<td>trill</td>
<td>tap</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
According to this scale, the distribution of the tap and trill can now be seen to follow from the sonority principles in (2.42a,b) below. (See Clements (1990) for more on the theory of Core Syllabification.)

(2.42)  

a. Greater sonority jumps are preferred in initial demisyllables.

\[*.[r\V] \quad (3 \rightarrow 4) \quad \sqrt{.[r\V]} \quad (0 \rightarrow 4)\]

\[\sqrt{.[C\r]} \quad (0 \rightarrow 3) \quad *[C\r] \quad (0 \rightarrow 0)\]

b. Smaller sonority falls are preferred in final demisyllables.

\[\sqrt{.[V\r]} \quad (4 \rightarrow 3) \quad *[V\r] \quad (4 \rightarrow 0)\]

As shown in (2.42a), the trill is preferred syllable-initially because it causes a greater sonority jump than does the tap. However, the tap is preferred as the second member of a complex onset because the trill is equivalent with obstruents in sonority and, therefore, causes no rise in sonority at all. The tap is also preferred in syllable-final position, as seen in (2.42b), since it causes a smaller sonority fall. Bonet and Mascaró argue that at the output of Lexical Phonology, all syllable-final rhotics are taps, which may be subsequently strengthened in emphatic speech at the postlexical level. As in the analysis of Harris (1983), emphatic strengthening is bled by postlexical Resyllabification. Sample derivations are given in (2.43):
Although they reject the representation of the surface trill as an underlying sequence of taps, Bonet and Mascaró still assume a postlexical deletion rule which deletes a word-final tap before a following trill (cf. Harris' (2.8d)). As with other, previously examined accounts positing a non-geminate representation of trill, it is not obvious how the blocking of /s/-epenthesis in Dominican Spanish is to be explained on the sonority-based account.

2.2.7 Summary

As we have seen in this section, numerous approaches to the analysis of Spanish rhotics have been adopted over the past two decades. According to Harris (1983), the tap /ɾ/ is the only rhotic in the segmental inventory of Spanish, and the surface trill [ɾ] is the product of derivational rules. On this account, the contrastive intervocalic trill is derived from an underlying sequence of taps. On the basis of hypercorrection facts in Dominican
Spanish, Núñez Cedeño (1988, 1994) further proposed that the intervocalic trill should be represented phonologically as a single underlying tap dually associated to two timing slots. In contrast, Lipski (1990) argued that the phonetic trill is the default realization of a single underlying tap surfacing in syllable-initial position, while lexically preattached taps in intervocalic position are treated as exceptions to this generalization. In more recent analyses, the trill continues to be represented as a single phonological unit underlingly, although different features have been invoked to distinguish it from the tap. In Morales-Front (1994) and Bakovic (1994), OT constraints determine the distribution of rhotic [ATR] values and Aperture configurations, respectively. In addition, sonority principles have become increasingly important in capturing the distribution of rhotics, especially in the most recent, rule-based account of Bonet and Mascaró (1997). Specifically, the trill is analyzed as being less sonorous than the tap, which accounts for the absence of the former segment from complex onsets and syllable rhymes in non-emphatic speech.

We have also seen several problems with respect to previous accounts. First, no provision is made by Lipski (1990), Morales-Front (1994) or Bakovic (1994) for a rule or constraint that ensures neutralization of postlexical tap + trill sequences to trill. Although the analysis of Núñez Cedeño (1988, 1994) might simply account for this by assuming Harris' (1983) tap deletion rule, a separate and somewhat redundant rule would still be necessary in order to convert the dually-linked geminate structure to a phonetic trill, which only complicates the grammar. Second, neither of the existing constraint-based analyses is capable of ensuring obligatory lenition to tap in word-final intervocalic
environments. Any OT account attempting to capture free variation in terms of unranked constraints must be supplemented with a mechanism to ensure taps in this context.

Finally, Núñez Cedeño (1994) argues that hypercorrective /s/-epenthesis in Dominican Spanish should be possible before intervocalic trills in an analysis positing a unitary underlying trill /ɾ/. While recent accounts have posited that the trill is a single unit, they have failed to show how the Dominican facts might be explained without the assumption that the surface trill is an underlying geminate.

### 2.3 Problematic Data from Other Languages

In addition to the problems just summarized, previous prosodic accounts of the Spanish tap/trill distribution face other challenges when data from beyond Spanish are taken into consideration. The basic difficulties stem from the fact that not all aspects of the behavior of rhotics can be adequately captured with reference to syllable structure alone. In this section, I present the following arguments:

1. The surface trill is ambiguous, patterning as a single phonological unit in some languages (e.g., Ngizim, Kaliai-Kove, and Kairiru), and as a cluster in others (e.g., Palauan and Kurdish). It is, therefore, not always feasible to represent the tap/trill contrast in terms of a singleton-geminate pair. However, some account must be given of the fact that the trill can surface as the phonetic reflex of an underlying cluster of taps.
2. In Basque and Kaliai-Kove, neutralized trill behaves in a manner not predicted by sonority principles, surfacing to the exclusion of the tap in complex onsets and syllable rhymes.

3. In Kairiru and Ngizim, obligatory neutralization to trill is conditioned not by syllable position but by the Place/stricture-sharing configuration of the cluster.

Each case is examined in turn in the following sections.

2.3.1 Trill as A Single Phonological Unit

Inouye (1995) examines languages in which the tap is in contrast with the trill in order to determine whether the contrast can be represented in terms of a phonological singleton-geminate relationship. Evidence from the domain of syllable structure, namely tests of consonant cluster behavior and closed syllable effects, suggests that it is not always feasible to interpret the phonetic trill as a cluster of taps, nor as a phonological geminate tap that is dually linked to the timing tier. The implication is that some other way must be found to represent contrastive rhotic duration, namely one in which both rhotics are single phonological units.

2.3.1.1 Vowel Length Restrictions in Ngizim

The first piece of evidence against trill-as-geminate comes from Ngizim, a Chadic language spoken in northeast Nigeria which contrasts an alveolar tap and trill. Schuh (1981) observes that modulo a few rare exceptions, long vowels do not occur in closed
syllables in this language. Now, consider the data in (2.44) below, in which the trill surfaces after long vowels. (N.B.: The ř is Schuh's phonetic symbol for the alveolar trill.)

(2.44) Trill after long vowels in Ngizim (Schuh 1981)

[ji:re]  jiře  'truth'
[ma:gi:ra]  maːgiːřa  'leader of the women in a town'
[nas:ar:a]  nasaːřa  'European'
[saːru]  saaːřu  'peer'

On an analysis such as that of Núñez Cedeño (1988, 1994), the first half of the geminate would be syllabified as the coda of the preceding syllable, while the second half would constitute the onset of the following syllable, as shown in (2.45):

(2.45) Trill as heterosyllabic geminate tap

\[
\begin{array}{c}
* \\
/ \sigma \sigma \\
| | \\
C V V C C V \\
| | | | \\
/ j i r e \\
\end{array}
\]

Since long vowels do not occur in closed syllables, the fact that the trill surfaces after long vowels suggests that it is not an heterosyllabic geminate straddling the syllable boundary.

A possible alternative would be to assume that the surface trill is indeed an underlying heterosyllabic cluster of taps, but that the cluster is reduced to a single trill. In the analysis of Harris (1983), the intervocalic cluster is reduced to a single onset-initial trill by strengthening the second tap and subsequently deleting the first (see the rules in (2.8b) and (2.8d), respectively). Now, if the restriction against long vowels is enforced
after these rules have applied, then the trill could surface after long vowels without
closing the preceding syllable. The problem with this alternative is that the relevant
constraint is most likely one that holds at the lexical level, where syllable building takes
place. On the other hand, the tap deletion rule must be postlexical in order to handle tap +
trill clusters that span the word boundary. Since postlexical rules apply after lexical ones,
an underlying cluster of taps could not be reduced to trill before violating the restriction
against long vowels in closed syllables.

The fact that the trill can occur after long vowels in Ngizim suggests that it is
patterned as a single phonological unit, shown in (2.46):

\[(2.46) \quad \text{Trill as single phonological unit}\]

\[
\begin{array}{c}
\sigma \\
\sigma \\
C \ V \ V \ C \ V \\
j \ i \ r \ e
\end{array}
\]

Lipski’s representation of the trill as a tautosyllabic geminate is another potential
alternative, since at no point does the first tap close the preceding syllable. The problem
with this approach is that since Ngizim does not allow complex syllable margins (Schuh
1978:279), a tautosyllabic geminate cannot constitute an onset cluster. In the following
sections, we will see that neither the heterosyllabic nor the tautosyllabic geminate
analysis is adequate for Kaliai-Kove and Kairiru. Like Ngizim, these languages require a
singleton representation of the trill, as shown in (2.46).
2.3.1.2 Reduplication and Consonant Clusters in Kaliai-Kove

In Kaliai-Kove, a language of the Austronesian family, reduplication serves the grammatical functions of durative and plural formation, among others (Counts 1969). The process is formalized and illustrated in (2.47):

(2.47) Reduplication in Kaliai-Kove

\[
\begin{align*}
\text{a. } & \text{RED} + C_1V C_2V \rightarrow C_1V C_2 C_1V C_2V \\
\text{b. } & /\text{bole}/ \quad \rightarrow [\text{bole}] \quad \text{'boar's tusk'}
\end{align*}
\]

Reduplication involves copying the first CVC string of the base word, as illustrated in (2.47b). Evidence that the trill is a single phonological unit comes from the fact that an entire trill reduplicates as a single segment in the coda of the copied CVC syllable, as shown in (2.48a). If the trill were an underlying (heterosyllabic or tautosyllabic) sequence of taps, only the first tap would reduplicate, as in (2.48b):

(2.48) a. Trill as a single phonological unit

\[
\begin{align*}
/i\text{yare}/ & \quad \rightarrow [i\text{yaryare}] \quad \text{'he copulates (durative)'}
\end{align*}
\]

b. Trill as a cluster or dually-linked geminate

\[
\begin{align*}
/i + \text{RED} + \text{yare} / & \quad \rightarrow *[i\text{yaryare}]
\end{align*}
\]

\[\text{20 Harris (1983) could circumvent this argument if the rules reducing the sequence of taps to a single trill could be made to apply prior to reduplication. However, this ordering is impossible given that reduplication is a word-formation (i.e., lexical) process, while tap deletion is postlexical.}\]
Furthermore, among the consonant clusters not created by reduplication are three which contain a consonant and a trill, as shown in (2.49):

(2.49) Kaliai-Kove trill in clusters

a. [yrem] 'somewhat, slightly'
   [mokrup] 'frog'

b. [mˈbarku] 'spirit mask type'

Under an analysis of the trill as a sequence of taps, these would constitute three-consonant clusters in the underlying representation (e.g., /γrr/, /krr/, /rrk/). However, three-consonant clusters do not otherwise occur in Kaliai-Kove, which suggests that the trill is a single phonological unit.

2.3.1.3 Syllable Structure in Kairiru

Kairiru, another language of the Austronesian family, provides more evidence of the trill patterning as a single phonological unit. Wivell (1981) argues that the syllable structure templates of Kairiru are as follows:

(2.50) Syllable structure templates for Kairiru

a. (C) (C) V (V) (C)
   (G)

b. CVVV

As made clear in (2.50), onset clusters are limited to no more than two consonants, while coda clusters are disallowed. In addition, Wivell notes that the only possible onset
clusters are of the form stop + liquid and fricative + non-fricative. While most consonants may combine across syllable boundaries, no geminate clusters have been observed in Kairiru.

Evidence that the trill is a phonological singleton comes from the fact that the tap and trill are contrastive in complex onsets and in coda position, as shown by the examples in (2.51):

(2.51) Kairiru tap/trill contrast in complex onsets and in coda position

| a. | [a.pri.ma.ru] 'he persuades them' | [for.pru] 'spotted snake eel' |
|    | [a.qrei] 'it is raining'          | [qra.pʰam] 'your shoulder'    |
| b. | [pur] 'pig'                       | [par] 'pebble'                |
|    | [wur] 'crayfish'                  | [wur] 'banana'                |

The postconsonantal trills in (2.51a) cannot be geminate clusters because the complex onsets would consist of three consonants. Similarly, the final trills in (2.51b) must be single units because coda clusters are not allowed.

2.3.2 Trill as A Phonological Geminate Tap

In contrast to the evidence just presented, there are several languages in which the trill appears to behave like a geminate tap. In Palauan, surface trills can result from a liquid assimilation process that produces a cluster of taps during morphological derivation. In Kurdish, single underlying taps can become adjacent in the formation of passive verbal forms. In both cases, the tap + tap sequence is realized phonetically as a single trill. These cases argue in favor of an analysis of trill as an underlying geminate tap.
2.3.2.1 Liquid Assimilation in Palauan

Palauan exhibits a process of liquid assimilation in which a lateral assimilates either to an adjacent rhotic or to a nearby rhotic across an intervening vowel. This process is prevalent in verbal morphology and can generate sequences of adjacent taps. Let us examine past tense infixation in perfective verbal forms as a representative case.

Perfective verbs in Palauan exhibit the following basic structure: verb marker + verb stem + object pronoun suffix (Josephs 1975:156). In (2.52), we find the verb marker /mə/, followed by the verb stem /dur/ 'burn, barbeque' which contains the infixed past tense marker /il/, followed by the object pronoun suffix /u/: 

\[(2.52) \text{ Liquid assimilation yields a cluster of taps in Palauan (Josephs 1975:166)}\]

\[
/mə + d + il + ul + úr/ \quad (\text{basic form, including infixed past tense marker } -il) \\
\]
\[
d + mə + il + ul + úr \quad (\text{by metathesis}) \\
\]
\[
d + m + il + ul + úr \quad (\text{by deletion of } ο) \\
\]
\[
d + u + il + ul + úr \quad (\text{by change of verb marker to } u \text{ in unstressed syllable}) \\
\]
\[
d + il + ul + úr \quad (\text{by deletion of verb marker}) \\
\]
\[
d + il + l + úr \quad (\text{by deletion of unstressed } u) \\
\]
\[
d + il + r + úr \quad (\text{by assimilation of } l \text{ to } r) \\
\]
\[
d + ir + r + úr \quad (\text{by assimilation of } l \text{ to } r) \\
\]
\[
[\text{dirúr}] \quad '\text{burned/barbequed it'}
\]

In the last step of the derivation, regressive assimilation changes the final lateral of the past tense infix to a tap, thereby producing a cluster with the final tap of the verb stem. This cluster is realized as a single trill in the phonetic representation. Josephs' account of
past tense infixation in (2.52) suggests that some Palauan trills result from morphologically derived tap clusters.

2.3.2.2 Passive Affixation in Kurdish

Abdulla and McCarus (1967) report that Kurdish \([\varepsilon]\) is "a flapped consonant, the tongue tip striking against the alveolar ridge" (9). This rhotic contrasts with the trill \([\varepsilon]\) in that the latter has a greater number of lingual vibrations. The two rhotics are contrastive in all positions within the word, except word-initially, where only the trill occurs. The trill is also morphologically derived when the passive tap morpheme is affixed to a verb stem which itself ends in tap. Passive affixation is illustrated in (2.53):

(2.53) Affixation of passive tap /\varepsilon/ in Kurdish (Abdulla and McCarus 1967)

<table>
<thead>
<tr>
<th>Active form</th>
<th>Passive form</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (\varepsilon)azæe</td>
<td>'he knows' (\varepsilon)azææ</td>
</tr>
<tr>
<td>b. (\varepsilon)øere</td>
<td>'he sends' (\varepsilon)øere</td>
</tr>
</tbody>
</table>

As shown in (2.53b), two taps that come to be adjacent in the derivation are realized as a single surface trill. This suggests that the trill is a cluster of taps phonologically.

2.3.3 Sonority and Neutralization to Trill in Basque and Kalai-Kove

One prediction of sonority-based accounts is that if the trill occurs as the second member of a complex onset or in rhyme position, then the tap should also be allowed to occur in
these same positions. To see this, let us assume the expository constraint SONORITY, which bans the less sonorous trill from complex onsets and rhyme position, and PARSE, which ensures faithful realization of underlying rhotics. If SONORITY outranks PARSE, then only the tap is allowed to occur. Tableau (2.54) illustrates this with respect to complex onsets:

(2.54) Ranking of SONORITY » PARSE ensures tap in C₂ of complex onsets

<table>
<thead>
<tr>
<th></th>
<th>SONORITY</th>
<th>PARSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /Cr/ → Cr</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>b. /Cr/ → Cr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. /Cr/ → Cr</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>d. /Cr/ → Cr</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Regardless of which rhotic is in the input, SONORITY guarantees that only the tap will surface as the second member of complex onsets, as demonstrated by candidates (2.54b,d).

Under the reverse ranking of PARSE » SONORITY, the prediction is that the tap and trill should contrast. Tableau (2.55) illustrates this, again with respect to complex onsets only:

(2.55) Ranking of PARSE » SONORITY ensures tap/trill contrast in C₂ of complex onsets

<table>
<thead>
<tr>
<th></th>
<th>PARSE</th>
<th>SONORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /Cr/ → Cr</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>b. /Cr/ → Cr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. /Cr/ → Cr</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>d. /Cr/ → Cr</td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>
If PARSE is top-ranked, then both an underlying tap and trill are allowed to surface faithfully, as shown by the optimal mappings in (2.55b,c).

The important observation here is that regardless of the ranking of SONORITY and PARSE, the faithful realization of an input trill in C₂ of a complex onset always entails the faithful realization of an input tap in the same position. That is, no ranking of these two constraints allows an input trill to surface without also allowing an input tap to surface.

However, evidence from Basque and Kaliai-Kove suggests that this prediction is typologically inaccurate. In Basque, only the trill surfaces in onset clusters and in rhyme position, as shown in (2.56):

(2.56) Basque trill in onset clusters and in rhyme position (Hualde 1991, Saltarelli 1988)

a. [pr]antziar 'French'
an[d̪r]e 'woman'

b. a[r.ɾ]o 'corn'
no[rk] 'who–ERG'
enbo[r] 'trunk'

In Kaliai-Kove, the trill patterns as it does in Basque, surfacing to the exclusion of tap in onset clusters and in rhymes:

(2.57) Kaliai-Kove trill in onset clusters and in rhyme position (Counts 1969)

a. [yrem] 'somewhat, slightly'
[mo.krup] 'frog'

b. [ⁿbar.ku] 'spirit mask type'
[na.par] 'dog's tooth net bag'
[tʰa.βur] 'trumpet'
In sum, neutralized trills in Basque and Kaliai-Kove behave in a manner not predicted by sonority principles. There must be some other factor responsible for the obligatory appearance of the trill in onset clusters and in rhyme position in these languages.²¹

2.3.4 Syllable Position and Neutralization to Trill in Kairiru and Ngizim

Syllable-based accounts of Iberian Romance post that the neutralization of postconsonantal rhotics to trill is dependent upon the heterosyllabicity of the cluster. This is evident in the structural description of Harris' postconsonantal fortition rule (2.8b), which I repeat for convenience below:

\[
\text{(2.58) } r \rightarrow r / [+\text{cons}] \_ \\
\text{Rhyme}
\]

This rule strengthens any tap occurring after an heterosyllabic consonant (e.g., /onra/ → [on.ra] honra 'honor'). Underlying taps surface unchanged after tautosyllabic consonants since the preceding consonant is no longer in rhyme position (e.g., /bra.so/ → [bra.so] brazo 'arm'). Note that Place specifications are not mentioned in the structural description of the rule in (2.58). On this analysis, the fact that the rhyme consonant shares Place with the following rhotic is treated as an incidental fact, irrelevant to the strengthening

²¹ The derivational account of Bonet and Mascaró (1997) faces a distinct and even more devastating problem. Recall that the trill is assumed to rank with obstruents on the sonority scale, as shown in (2.41). Since Clements' (1990) Core Syllabification algorithm cannot parse two segments of identical sonority as members of an onset cluster, the trill should be universally banned from appearing in C₂ of complex onsets—contrary to fact.
process. Rather, syllable position—more specifically, heterosyllabicity—is the key determinant of postconsonantal neutralization to trill.

Two other languages of the rhotic duration typology also exhibit neutralization to trill in certain consonant-adjacent positions. In both cases, however, homorganicity—more specifically, Place/stricture-sharing—is the driving force behind neutralization, not syllable position. For instance, only the trill surfaces after alveolar consonants in Kairiru, as seen in (2.59):

(2.59) Neutralization to trill after tautosyllabic homorganic consonants, but contrast after tautosyllabic heterorganic consonants (Wivell 1981)

a. [al.sru] 'he chops them down'
   [sru] 'pair, brace'
   [wun.tru] 'I close the door'

b. [a.pri.ma.ru] 'he persuades them'
   [for.pru] 'spotted snake eel'
   [a.qrei] 'it is raining'
   [qra.p^am] 'your shoulder'

While heterosyllabicity is argued to be crucial for postconsonantal strengthening in Iberian Romance, the same cannot be true for the examples in (2.59a) because the relevant clusters are all tautosyllabic. Rather, postconsonantal neutralization to trill in Kairiru depends on the homorganicity of the cluster—more specifically, the Place/stricture-sharing configuration present in the feature-geometric representation of the clustering segments. In contrast, the tautosyllabic clusters in (2.59b) involve heterorganic segments that do not share Place. Therefore, neutralization to trill is not
obligatory in non-Place/stricture sharing configurations, as shown by the fact that tap and trill are contrastive in these clusters.

Further evidence that syllable position does not condition neutralization to trill comes from Ngizim. This language contrasts an alveolar tap and trill in all positions except before coronal stops [t, d, d, n] and lateral fricatives [l, l] (Schuh 1981:xi). The examples in (2.60) show obligatory trills in these contexts, while contrast maintenance in other preconsonantal contexts is shown in (2.61):

(2.60) Ngizim trill before coronal stops and lateral fricatives

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>sɔ[r.ʈ]u</td>
<td>'string beads'</td>
<td>a[r.d]aatu</td>
</tr>
<tr>
<td>ga[r.d]u</td>
<td>'cut notch in'</td>
<td>ku[r.n]a</td>
</tr>
<tr>
<td>ga[r.l]a</td>
<td>'strong in taste, bitter'</td>
<td>ngu[r.ŋ]adliya</td>
</tr>
</tbody>
</table>

(2.61) Ngizim tap/trill contrast before other consonants

a. Before labials
   ka[r.m]u | 'cut down' |
   kɔ[r.m]ai | 'chieftainship' |

b. Before alveolar fricatives
   ku[r.s]aasiya | 'kidney' |
   bɔ[r.z]anzan | 'rolling around on the ground' |

c. Before palatals
   aatɔ[r.]an | 'perfume' |
   pɔ[r.ʃ]i | 'lip' |

d. Before velars
   tɔ[r.k]u | 'orphan' |
   tɔ[r.k]akdu | 'repeatedly press on' |
Following proposals by Holt (in press) and Walsh (1997), I assume that both coronal stops and lateral fricatives are specified as noncontinuant with respect to alveolar constriction, while the lateral fricatives are additionally specified for lateral fricative release. 22 This assumption makes possible the following generalization about preconsonantal rhotics in Ngizim: the trill is obligatory before any consonant that has alveolar closure, as in (2.60), while either the tap or trill may surface before all other consonantal articulations, as in (2.61).

In sum, neutralization to trill in Kairiru and Ngizim is not dependent on syllable position, since neutralized trills occupy the same syllable position as their contrastive counterparts. Any account attempting to explain these instances of neutralization must make reference to the place specifications of the adjacent consonant.

2.4 Conclusion

The main focus of this chapter has been the distribution of the tap and trill in general Spanish. Previous accounts were reviewed and assessed, and problematic data were then presented from languages beyond the Iberian Romance family. In the following chapter, a phonetically-based OT account is developed which overcomes the inadequacies of syllable-based approaches. In Chapter 4, this account will be shown to capture the distribution of rhotics in languages beyond Spanish.

22 See Section 4.4.2.1 of Chapter 4 for more on the feature geometry of lateral fricatives.
Chapter 3

A Phonetically-based Optimality-theoretic Analysis of Spanish Rhotics

In this chapter, I develop an OT analysis of the rhotic duration typology, with Spanish serving as the primary example. Inspired by recent proposals of Flemming (1995), Kirchner (1997, 1998), and Steriade (1995a, 1997, 1999a, 2001a,b), the analysis posits that phonetic and phonological constraints interact directly to determine the surface distribution of rhotics without reference to syllable boundaries. Since reference to syllable structure is unnecessary, the analysis developed here does not face the same difficulties as existing prosodic accounts when data beyond general Spanish are taken into account. In Chapter 4, the analysis is shown to make the right predictions with respect to other languages of the typology.

3.1 Phonetic Properties of Coronal Tap and Trill

The representations and constraints posited in a phonetically-based OT analysis are motivated to the extent that they are grounded in the phonetic properties of the patterns they are meant to explain. This section explores the articulatory and perceptual characteristics of the coronal tap and trill, thereby laying the groundwork for the representations and constraints to be proposed and illustrated in subsequent sections.
3.1.1 Tap

3.1.1.1 Perception

The coronal tap is characterized by an extremely short constriction period. Quilis (1993:337-342) observes that for Castilian Spanish, the average duration of contact is 20 ms, and that the constriction is seldom a complete closure. Walsh (1997:96) notes that cross-linguistically, the tap is characterized by two perceptually-driven tendencies, *inter-sonority* and *anti-peripherality*. That is, taps exhibit a preference for intervocalic position and tend to avoid word-edges in order to maintain sonority and enhance perceptibility.

*Figure 3–1* illustrates the intervocalic tap with an example from Spanish:23

---

23 The tokens under spectrographic analysis in this chapter were taken from recordings of literary readings done by native Spanish speakers from Ecuador.
Acoustically, the intervocalic tap of the sequence [era] constitutes a brief disruption (approximately 20 ms) of the surrounding vocalic formant structure. *Figure 3–1* provides visual confirmation of Walsh’s (1997) description of the tap as “a quick coronal interruption of surrounding segments” (141).

It should be noted that the cross-linguistic preference for intervocalic position is a tendency rather than an absolute, as evidenced by languages in which taps surface in non-intervocalic position. Even in these cases, however, it is still possible to observe a preference for the tap constriction to be flanked by periods of greater sonority. In
consonant clusters, a svarabhakti vowel fragment typically intervenes between the tap and the adjacent consonant.\textsuperscript{24} This fragment has formant structure similar to the nuclear vowel that appears on the opposite side of the tap constriction (see Quilis 1993:337-342 for a detailed discussion of the acoustic properties of svarabhakti in Spanish consonant clusters). The spectrogram in \textit{Figure 3–2} illustrates svarabhakti in the Spanish word \textit{muerte} 'death'. (N.B.: A superscript is used in narrow phonetic transcription to represent the svarabhakti vowel fragment.)

\textsuperscript{24} Whitney (1889) employs the term \textit{svarabhakti} to denote the vowel-like fragment that intervenes between the retroflex rhotic and an adjacent stop or spirant in Sanskrit. Early references to svarabhakti in the Hispanic literature are found in Gili Gaya (1921), Lenz (1892, 1893), Malmberg (1965), and Navarro Tomás (1918).
The formant structure of the vowel fragment is essentially a continuation of the full vowel preceding the 20 ms constriction period of the tap. Whereas inter-sonority is ensured by two flanking vowels in intervocalic position, as shown in Figure 3–1, only one vowel—that preceding the tap constriction—is available to provide flanking periods of greater sonority in tap + consonant sequences. The same holds true of phrase-final position, where word-final svarabhakti is a continuation of the vowel preceding the word-final tap, as shown in Figure 3–3:

Figure 3–2: Svarabhakti vowel fragment in Spanish *muerte* 'death'
In the following section, I examine the articulatory properties of the coronal tap. It will be argued that the presence of svarabhakti in non-intervocalic positions depends on the degree of gestural overlap between the tap and the tautosyllabic vowel. The preference for intervocalic position stems from the greater likelihood that svarabhakti will be perceptually compromised in non-intervocalic positions due to variability in gestural timing.

*Figure 3–3: Svarabhakti vowel fragment in Spanish ayer 'yesterday'*
3.1.1.2 Articulation

Articulation of the tap involves a ballistic gesture whereby the tongue tip is thrown up against the alveolar ridge (Ladefoged 1993:168). In order for this articulation to be successful, both the approach and release phases must be properly implemented (Inouye 1995:55-6). The tongue tip must be "coocked" back from neutral position to gain momentum for tapping, and it must move away quickly from the point of contact if extra-short constriction is to be achieved. Inouye invokes the metaphor of throwing a baseball, which also involves a ballistic gesture with similar approach and release phases. The throw will be more effective if one's arm is cocked back from rest position in order to gain momentum and if it is also allowed to follow through on its movement trajectory after the baseball is released. As in the case of throwing a ball, the ballistic tapping gesture is most effective when approach and release phases are properly executed.

When the tap occurs in intervocalic position, the flanking vowels provide periods of greater aperture which facilitate implementation of the approach and release phases of the tapping gesture. In those languages in which taps surface in non-intervocalic position, a svarabhakti vowel fragment was shown to intervene between the tap and an adjacent consonant or phrase boundary in order to ensure perceptibility of the tap as a brief interruption of surrounding sonority. The preference for intervocalic position stems from the fact that the svarabhakti vowel fragment may be perceptually compromised in non-intervocalic positions by differences in gestural timing.

The gestural model of Browman and Goldstein (1986, 1989a,b, 1990, 1992) provides a framework within which to examine issues of gestural timing. This framework
posits that phonetic timing is intrinsic to the phonological representation, and gestures are
to be taken as phonological primes, as well as units of articulation. However, others have
argued that gestural representations contain more detail than is needed to capture possible
categorical alternations and contrast (see Clements 1992, Kingston and Cohen 1992,
1990) and Pierrehumbert (1990) propose that both qualitative and quantitative
representations are motivated and should exist independently. In this dissertation,
however, I assume that phonological contrast is enforced by constraints directly in the
surface representation. The implication is that phonological representations may be
specified with much richer detail than typically assumed, including non-contrastive
information such as the inherent duration of articulatory gestures or properties such as
consonantal release. Since the well-formedness of phonological contrasts is governed
independently by the constraint system, the inclusion of non-contrastive detail in
representations no longer poses the threat of generating spurious contrasts. (See the
discussion in Section 1.2.2 of Chapter 1.)

The claim that gestural timing determines svarabhakti rests on two assumptions
about the timing of consonant and vowel gestures, namely that (1) the vocalic gestures in
a /VCV/ sequence are articulatorily contiguous, and (2) consonantal gestures are
superimposed on vocalic gestures (Öhman 1966). Gafos (1999) makes the following
observation with respect to /VCV/ sequences:

"During the consonantal constriction the vowel is not heard because the
acoustic signal produced by the vocal tract is dominated by the narrowest
constriction (silent during a stop, noisy during a fricative, and so on).
Thus, the vowel formants, or the acoustic effects of the vowel, are
necessarily absent during the consonant. However, the gesture of the vowel, being a positioning of the tongue body, still overlaps with the gesture of the consonant" (32).

The overlap between consonant and vowel gestures explains why svarabhakti in non-intervocalic positions is always a continuation of the formant structure present on the opposite side of the tap constriction. Both the full vowel and the vowel fragment stem from the same tongue body gesture, and the superimposed tapping gesture produces a brief interruption separating the two.

Steriade (1990) proposes a gestural analysis to explain the presence of vowel fragments in tautosyllabic onset clusters of the form consonant + rhotic. Specifically, the tongue tip gesture for the rhotic moves to a non-peripheral position in the syllable, thus creating a sequence in which the overlapping vowel gesture begins to appear between the consonantal gestures. I refer to this scenario as non-peripheral timing, meaning that the rhotic gesture moves toward the center of the full vowel. Non-peripheral timing is also a possibility for rhotic + consonant sequences. The gestural representation in Figure 3–4 shows how non-peripheral timing in a /V₁rCV₂/ sequence uncovers the acoustic identity of V₁ before the following dental stop gesture is initiated:
Figure 3–4: Non-peripheral timing of tap and V₁ gestures produces svarabhakti vowel fragment in Spanish *muerte* 'death'

The formalism in *Figure 3–4* provides a visual representation of gestures, which are linguistically significant articulatory movements that produce a constriction in the vocal tract (Browman and Goldstein 1986, 1989a,b, 1990, 1992). The activity of each articulator is depicted on a separate tier, whose labels appear at the left. Boxes represent gestures, and the length of a box denotes the period of time during which the articulator is under active control. Gestures that overlap on the same articulatory tier are indicated by dotted lines (e.g., the contiguous tongue body gestures of V₁ and V₂). Finally, the waveform appearing at the top is taken from *Figure 3–2* and illustrates the acoustic results of the articulatory configuration.
Let us consider the opposite scenario, namely peripheral timing, whereby the rhotic gesture moves away from the center of the full vowel. A slight delay in the initiation of the alveolar tongue tip gesture in Figure 3–4 would result in the perceptual masking of the tap's release phase by the following consonant. No svarabhakti vowel fragment would be audible under this timing scenario, as Figure 3–5 demonstrates with the same example from Spanish:

![Waveform and tongue movements](image)

*Figure 3–5:* Peripheral timing of tap and V₁ gestures results in perceptual masking of svarabhakti vowel fragment in Spanish *muerte* 'death'

The absence of svarabhakti under peripheral timing is demonstrated in the waveform, from which the amplitude of the vowel fragment has been spliced in order to show the...
acoustic effects of consonantal overlap with the following stop gesture. Loss of the svarabhakti vowel presumably diminishes the perceptibility of the tap, which may subsequently be interpreted by the listener as reduced or, in the extreme case, elided.\textsuperscript{25}

Differences in gestural timing also determine the presence of svarabhakti when the tap surfaces adjacent to a phrase boundary, as demonstrated in Figures 3–6 and 3–7:

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure3-6.png}
\caption{Non-peripheral timing of tap and V gestures produces svarabhakti vowel fragment in Spanish \textit{ayer} 'yesterday'}
\end{figure}

\textsuperscript{25}To my knowledge, no perception-based studies exist in the literature to support the hypothesis that the loss of svarabhakti leads to diminished perceptibility of the tap. I shall not pursue the issue at present, but see Section 5.4.2.2 of Chapter 5 for a discussion of how such a perceptual experiment might be carried out.
In Figure 3–6, non-peripheral timing uncovers the acoustic identity of the final portion of the vowel before the cessation of voicing in phrase-final position. In Figure 3–7, peripheral timing hides the audible release of the tap, thereby compromising its perceptibility.

In order to understand the inter-sonority and anti-peripherality preferences observed by Walsh (1997), we must compare the non-intervocalic taps shown above with the intervocalic tap shown in Figure 3–8:
In non-intervocalic positions, svarabhakti vowel fragments are subject to perceptual masking under peripheral timing scenarios. Intervocally, however, there is no such threat because the lexically specified full vowels automatically guarantee flanking periods of greater sonority. With respect to ensuring the perceptibility of the tap, a full vowel is better than a vowel fragment, since the realization of the latter may vary as a function of gestural timing.
3.1.2 Trill

3.1.2.1 Perception

In contrast to the extra-short tap, the alveolar trill is characterized by a sustainable duration. The average overall duration of the trill in Castilian Spanish is approximately 85 ms with 3 occlusions (Quilis 1993). Harris (1983:62) notes that the Mexican Spanish trill may be realized with 2 to 10 vibrations, although the longer realizations are typical of emphatic speech. Perceptually, the trill has an inherently salient acoustic structure, consisting of vocalic formant values briefly interrupted by periods of stop-like silence (Widdison 1997:190). The spectrogram in Figure 3–9 illustrates the intervocalic trill with an example from Spanish:
The intervocalic trill shown above is approximately 96 ms in total duration and exhibits three occlusions. The alternation of vocalic formant structure and periods of constriction makes the trill perceptually salient. This contrasts with the alveolar tap, which requires some degree of surrounding sonority to ensure the perceptibility of its brief constriction.

*Figure 3–9: Perceptually salient acoustic structure of intervocalic trill in Spanish mediterráneos 'Mediterranean'*
3.1.2.2 Articulation

Whereas the tap involves a ballistic tongue tip gesture, the trill requires a tensed, controlled, and precise gesture in order to initiate passive vibration of the articulator by virtue of the Bernoulli effect (Catford 1977, Ladefoged and Maddieson 1996). The principal articulatory difference between the two rhotics is that the tap involves a momentary constriction, while that of the trill may be sustained. As Catford (1977) argues, the trill is not simply a sequence of taps because the two rhotics involve completely different production mechanisms:26

"A flap … is a single ballistic flick or hit-and-run gesture. A trill … is a maintained and prolongable posture: the vibrations that occur in a trill are aerodynamically imposed on the posture. Any idea that a trill is a 'rapid series of flaps', or that a flap is just an 'ultra-short trill' is quite wrong. The frequency of alveolar and uvular trills [r] and [] is of the order of 30 cycles per second. This is much higher than the maximum rate at which one can produce a series of [r]-flaps (about five or six per second)" (130).

This is true even for languages in which the tap and trill appear to stand in a singleton-geminate relationship:

"… [T]here are languages in which flap and trill, for example, [r] and [r], are opposed to each other as the 'short' and 'long' members, respectively of a phonological correlation of duration or 'quantity' as it is often called; but … from a rigorous phonetic point of view a trill is not a lengthened flap" (196).

26 Catford (1977) uses the term flap in referring to lingual articulations of extra-short constriction duration. In addition, he distinguishes between flicks and transient flaps, which differ primarily with respect to the position of the tongue tip upon completion of the gesture. For present purposes, I collapse this distinction and continue to employ the term tap.
Figure 3–10 contrasts in diagrammatic form the articulatory trajectories of the
tongue tip in both the coronal tap and trill. While the active articulator makes a single
strike against the alveolar region in the former, multiple contacts arise in the latter as the
result of passive vibrations imposed on a held posture:

Tap           Trill

Figure 3–10: Articulatory trajectories of the tongue tip in coronal tap versus trill (from
Catford 1977:134)

That the trill is not an articulatory sequence of individual tapping gestures is captured in
gestural representations by the fact that there is only one tongue tip gesture responsible
for passive vibratory movement.27 Unlike the shorter tapping gesture shown in Figure 3–
8 above, the duration of the gesture for the trill may be sustained long enough to initiate
passive vibration of the tongue tip. Figure 3–11 demonstrates the intervocalic trill in
Spanish:

27 On the basis of electropalatographic and acoustic measurements of VrV and VrV
sequences in Catalan, Recasens and Pallarès (1999) also argue that the trill is not a
geminate correlate of the tap due to differences observed in lingual articulation and C-to-
V coarticulation effects.
3.1.3 Perceptibility Scale for Rhotic Duration Contrast

The phonetic properties of the coronal tap and trill examined in Section 3.1 are summarized and contrasted in Table 3–1 below. The extremely short duration of the tap was shown to motivate the perceptual and articulatory requirements of this segment. These requirements are best satisfied in intervocalic position, where the surrounding full vowels provide an optimal acoustic backdrop and facilitate the approach and release phases of the ballistic tapping gesture. On the other hand, the inherent salience of the trill ensures perceptibility in any context, albeit at a greater articulatory price since more precision is required to ensure trilling.

*Figure 3–11:* Passive vibration of tongue tip produces inherently salient acoustic structure of trill in Spanish *mediterrâneos* 'Mediterranean'
Taken together, the perceptual and articulatory considerations relevant to the tap and trill motivate the following perceptibility scale for rhotic duration contrast:

(3.1) Perceptibility scale for distinctive rhotic duration (to be revised)

\[ V \_V > \# \_V, \ C \_V, \ V \_\#, \ V \_C \]

According to this scale, rhotic duration is more perceptible in intervocalic position than in positions where rhotics surface adjacent to a word edge or a consonant. The weighting of these contexts directly reflects the inter-sonority and anti-peripherality preferences of the tap, which were discussed in detail in the preceding sections.

Of the consonant- and word-adjacent contexts grouped together in (3.1), one context merits further discussion, namely word-initial position. Cross-linguistic evidence suggests that this position benefits from inherent perceptual prominence in that more phonological contrasts tend to be licensed there.\(^{28}\) In addition to the phonological

\[^{28}\text{In an OT approach such as Beckman's (1998) positional faithfulness, input-output correspondence constraints can target those syllabic or prosodic positions that are more prominent, such as root- or onset-initial positions (e.g., the constraint CONTRAST(voi/onset), which was discussed in Section 1.2.3.1 of Chapter 1).}\]

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**Table 3–1: Summary of phonetic properties of coronal tap and trill**

<table>
<thead>
<tr>
<th></th>
<th>Tap</th>
<th>Trill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration</td>
<td>Momentary</td>
<td>Sustainable</td>
</tr>
<tr>
<td>Perception</td>
<td>Inter-sonority, anti-peripherality, svarabhakti</td>
<td>Inherently salient acoustic structure</td>
</tr>
<tr>
<td>Articulation</td>
<td>Ballistic gesture with approach and release phases</td>
<td>Tense, controlled, and precise posture</td>
</tr>
</tbody>
</table>
evidence, there is also psycholinguistic motivation for the perceptual salience of word onsets (see Hawkins and Cutler 1988 and the studies cited therein). The greater perceptibility of word-initial contexts can be captured by increasing its rank along the scale of (3.1). The result is shown in (3.2):

(3.2)  Perceptibility scale for distinctive rhotic duration (final version)

\[ V_V \succ \#_V \succ C_V, V_C, V_\# \]

This final scale encapsulates the speaker's knowledge that contrast between the tap and trill is most perceptible between vowels. Similarly, the perceptual prominence of word onsets places word-initial above the elsewhere contexts. It is precisely this knowledge that motivates the universal ranking of contrast maintenance constraints in the grammars of languages that exhibit a phonological contrast between the tap and trill. The remainder of this chapter provides a formal characterization of these grammars, with Spanish serving as the primary example.

### 3.2 Constraints of The Analysis

In this section, I present an analysis of rhotic duration contrast and neutralization in terms of ranked and violable OT constraints. The analysis incorporates two general types of constraint. Contrast maintenance constraints strive to preserve phonological contrast between the tap and trill in different positions. Articulatory markedness constraints interact with contrast maintenance, thereby generating different patterns of neutralization as a function of ranking.
3.2.1 Contrast Maintenance

The special nature of intervocalic and word-initial contexts can be captured by relativizing CONTRAST(F) constraints to these positions and ranking them higher than context-free CONTRAST(F). Specifically, the CONTRAST(duration) constraints in (3.3) seek to maintain rhotic duration contrast between vowels (3.3a) and word-initially (3.3b) over all other positions (3.3c), as formalized by the universal ranking in (3.3d).

(3.3) Constraints on the preservation of tap/trill contrast

a. CONTRAST(dur/V_V)
   Maintain rhotic duration contrast between vowels

b. CONTRAST(dur/#_V)
   Maintain rhotic duration contrast word-initially

c. CONTRAST(dur)
   Maintain rhotic duration contrast

d. Tap/trill contrast preservation hierarchy
   CONTRAST(dur/V_V) » CONTRAST(dur/#_V) » CONTRAST(dur)

The hierarchy in (3.3d) results from the alignment of constraints to the perceptibility scale for rhotic duration contrast shown in (3.2).29

The constraint ranking directly captures the implicational relationships among contrastive positions across the languages of the rhotic duration typology discussed in Chapter 1, which are repeated for convenience in (3.4):

29 The notion of aligning constraints to harmonic scales was discussed in Section 1.2.4 of Chapter 1.
where contrast in Position x entails contrast in Position y iff y < x.

Both the ranking of constraints in (3.3d) and the empirical generalization captured in (3.4) are argued to follow from the perceptibility scale in (3.2), which derives in turn from the physiological and physical properties of speech production and perception (see Section 3.1).

### 3.2.2 Articulatory Markedness

Interacting with the CONTRAST(duration) hierarchy in (3.3d) are two types of markedness constraint on the articulatory representation of rhotics. Below, I present the representations and show how the constraints govern different aspects of their structure.

#### 3.2.2.1 Representations

The analysis developed here captures the duration contrast between the tap and trill in terms of Aperture Theory, which encodes stricture via three degrees of aperture: oral closure $A_0$, release $A_{\text{max}} (A_m)$, and an intermediate aperture $A_f$ generating fricative turbulence (Steriade 1993, 1994). I follow Inouye (1995:348) in positing a degree of aperture responsible for trilling that is intermediate between stops and fricatives, formalized here as $A_{\text{trill}} (A_t)$. Finally, $A_v$ denotes vocalic aperture. The complete aperture scale is shown in (3.5):

\[
\begin{align*}
(3.4) & \quad \text{Position 1} \quad < \quad \text{Position 2} \quad < \quad \text{Position 3} \\
& \quad \text{Intervocalic} \quad \text{Word-initial} \quad \text{Heterorganic clusters}, \\
& \quad \text{Word-final}
\end{align*}
\]

where contrast in Position x entails contrast in Position y iff y < x.
On the assumption that stricture is dominated by Place in the feature geometry (Padgett 1994, 1995), I propose (3.6a) and (3.6b) as the correct representations of the tap and trill, respectively:

(3.6) Aperture-theoretic representations of tap and trill

a. Tap: cor

\[ \begin{array}{c}
\text{A}_m \text{A}_t \text{A}_m \\
\text{= approach + constriction + release}
\end{array} \]

b. Trill: cor

\[ \begin{array}{c}
\text{A}_t \\
\text{= constriction}
\end{array} \]

The above representations closely follow the formalisms proposed by Inouye (1995), although my assumptions diverge somewhat. First, Inouye employs a numerical, multi-valued aperture scale, whereby integer values are assigned to different stricture degrees (e.g., [0] for stops, [1] for trills, [2] for fricatives, and [3] for fricatives). In contrast, the formalisms in (3.6) are cast in terms of the aperture scale shown in (3.5), which also incorporates an aperture position denoting vowels, \( \text{A}_v \). Second, with respect to the location of aperture positions within the feature geometry, Inouye states that

"it is not clear whether the APERTURE feature should replace the entire manner node, or whether it is an articulator-specific feature that resides under the active articulator node (e.g., CORONAL). The repercussions of such a proposal need to be considered carefully. We will conservatively assume for now that it resides under the MANNER node" (91).
My proposal diverges crucially in that aperture positions are assumed to be featural dependents upon the Place node, in accordance with Padgett (1994, 1995). This assumption is motivated by the behavior of rhotics in Place-sharing clusters (see Section 3.2.2.1 below). Finally, despite the differences between Inouye (1995) and the present proposal, both analyses converge on the assumption that aperture positions constitute privative features.  

The representations in (3.6) treat distinctive rhotic duration as a segmental property by directly encoding the articulatory phases of tap and trill segments. The peripheral $A_m$ positions of the structure in (3.6a) denote the approach and release phases of the coronal tap gesture. They make possible the ballistic articulatory maneuver necessary for a momentary $A_t$ constriction at the alveolar ridge. In contrast, peripheral $A_m$ positions are absent from the representation of the trill in (3.6b). As a result, the single $A_t$ constriction of the trill may be prolonged sufficiently to initiate passive vibration of the tongue tip by the Bernoulli effect.

A question arises here as to what exactly determines the relative duration of the $A_t$ constriction in (3.6a) versus that in (3.6b). Rather than positing the existence of some violable, grammatical constraint that dictates the duration of the $A_t$ nodes in these configurations, I claim instead that these durational differences are a consequence of

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30 Privative features differ from binary features in that the latter may be specified with either a $+$ or $-$ value (e.g., a $[+F]$ specification contrasts with a $[-F]$ specification). In contrast, privative features lack binary specifications and are simply either present or absent with respect to a given representation (e.g., the presence of $[F]$ contrasts with its absence).

31 Thanks to Eric Bakovic for raising this issue.
universal phonetics. Under the proposed representations, both the tap and trill are treated as single segments dominated by a single timing slot. Let us assume that a phonological timing slot is assigned some unspecified interval of time for the phonetic realization of the segment with which it is associated. Now, if this interval is held constant across different subsegmental configurations, it follows that the time span allotted to a single \( A_t \) node will be greater relative to the time span allotted to an \( A_t \) node that must share its timing slot with two adjacent \( A_m \) nodes.\(^{32}\)

The relative duration of the \( A_t \) constriction in the tap versus the trill configuration is illustrated in Figure 3–12 (N.B.: Boxes represent the total time interval assigned to a single timing slot, while shading denotes the duration of the \( A_t \) constriction relative to this interval.)

![Figure 3–12: Schematic relative duration of \( A_t \) constriction in tap versus trill](image)

These schematic diagrams illustrate how the flanking \( A_m \) nodes of the tap preclude a longer constriction duration of the \( A_t \) node vis-à-vis the trill. In sum, the aperture-

\(^{32}\) See Inouye (1995:97-98) and Sagey (1986:86) for a similar discussion of the relative duration of singly-linked stops and fricatives versus their affricate-contour counterparts.
theoretic representations in (3.6) reflect the articulatory properties of the extra-short tap as a ballistic gesture and of the longer trill as an articulatory posture upon which vibratory cycles are aerodynamically imposed (see Section 3.1).

3.2.2.1.1 Evidence for Tap as Aperture Contour

Evidence in support of the contour representation of the tap in (3.6a) comes from alternations among taps, coronal stops, and trills. The cross-linguistic survey of Inouye (1995) reveals processes whereby stop and trill lenite to tap between vowels, as well as the opposite process of fortition of tap to stop or trill in non-intervocalic environments. Aperture Theory provides a formal representation—the tap as an aperture contour—which captures the complementary nature of lenition and fortition. "Where lenition is spreading of aperture, fortition is the delinking of the approach branch and/or failure to project the release branch of the three-branched tap" (Inouye 1995:156). This section focuses on these lenition and fortition processes.

Inouye's autosegmental analysis presupposes an input-output mapping, as made evident by notions such as "spreading," "delinking," and "failure to project." Recall, however, that under the Dispersion-theoretic assumptions of this dissertation, constraints operate directly on surface representation without reference to underlying representation. Input forms are considered unnecessary and are omitted from tableaux (see Section 1.2.2.2 of Chapter 1). In the following discussion, I shall not attempt a formal reanalysis of Inouye's accounts of lenition and fortition processes involving taps, coronal stops, and trills. For present purposes, therefore, let us focus on the aperture representations while
acknowledging the differences between assumptions with respect to input-output mappings. The goal here is simply to motivate the representations of the tap as an $A_mA_vA_m$ contour and of the trill as a single $A_t$ position.

### 3.2.2.1.1 Lenition as Spreading of Aperture

In American English, coronal stops /t, d/ are lenited to tap [ɾ] under certain prosodic conditions in contexts where surrounding aperture is approximant or greater: *batting* [bæɾtŋ] versus *banter* [bæntɔr] and *Betsy* [bɛtsi] (Inouye 1995:55-59). In Aperture Theory, plosives are represented as bipositional sequences of closure + release, $A_0A_m$ (Steriade 1993, 1994). In prevocalic position, the $A_m$ release position of a plosive undergoes merger with the $A_v$ position of a following vowel. This is the representational equivalent of the statement that plosives are released into following vowels. When plosives undergo tapping, a contour representation is derived by the spreading of surrounding vocalic aperture onto the intervening $A_0$ stop closure, as shown in (3.7):

\[
(3.7) \quad \text{Temporal lenition of stop as spreading of vocalic aperture}
\]

\[
/VtV/ \quad \Rightarrow \quad [VrV]
\]

\[
\begin{array}{c}
\text{cor} \\
A_v \\
\text{cor} \\
A_v A_0 A_m A_v
\end{array}
\quad
\begin{array}{c}
\text{cor} \\
A_v \\
\text{cor} \\
A_v A_0 A_v
\end{array}
\]

Differences between the representation of the underlying tap in (3.6a) and the derived structure in (3.7) involve both the central and peripheral aperture positions. While an underlying tap has a central $A_t$ constriction flanked by phonologically-specified $A_m$
release and approach branches, tapping of an underlying stop yields a structure in which flanking $A_v$ positions have spread onto the central $A_0$ position. In both cases, the extra-short duration of the central constriction is ensured by the association of surrounding aperture values of approximant or greater (i.e., $A_m$ or $A_v$). The aperture contour is derived in the tapping of stops but phonologically specified in the case of phonemic tap.

Inouye (1995, Ch. 4) reports a common cross-linguistic pattern whereby surface tap is derived from underlying intervocalic trill in a manner similar to the spreading analysis of American English tapping. Assuming the representation of the trill in (3.6b), derivation of tap from intervocalic trill may be captured as an instance of aperture spreading:

(3.8) Temporal lenition of trill as spreading of vocalic aperture

$$/VrV/ \rightarrow [VrV]$$

As with the lenition of intervocalic stops in American English, lenition of intervocalic trills results in an aperture contour derived by spreading. When the flanking $A_v$ positions come to associate to the intervening trill, the duration of the central $A_t$ constriction is reduced enough to prevent passive vibration of the tongue tip.

In sum, the temporal lenition of coronal stops and trills constitutes evidence in favor of the contour representation of the tap in (3.6a). In both cases, spreading of surrounding vocalic aperture onto the central aperture position reduces the duration of the latter, thereby preventing longer duration of stops and passive vibration of trills.
3.2.2.1.2 Fortition as Delinking of Aperture

If lenition is the spreading of aperture, then it is plausible to view fortition as its formal counterpart, namely delinking. Inouye (1995, Ch. 2) identifies the contexts in (3.9) as typical phonetic environments in which phonemic taps undergo fortition to stops cross-linguistically:

(3.9) Typical fortition environments

\[
/t/ \rightarrow [t, d, n] / \# _{\text{C}} \#_{\text{C}}
\]

The contour representation of phonemic tap provides a natural account of fortition in these contexts. In those languages exhibiting alternations between taps and stops, Inouye assumes that the tap is phonologically specified as an aperture contour in which a central A₀ position is flanked by Aₘ positions. When the branching structure of the tap is adjacent to another consonant or word-boundary, delinking of the adjacent Aₘ position may take place. This is schematized in Figure 3–13:

\[
/t/ \rightarrow [t, d, n]
\]

**Figure 3–13**: Fortition of phonemic tap as delinking of aperture (cf. Inouye 1995:136)
The result of delinking a peripheral $A_m$ position would not sound like a tap because the closure duration is lengthened to that of a normal stop (oral or nasal). This analysis of fortition also applies to those languages in which phonemic taps strengthen to trills, except that in this case the tap would be phonologically specified with a central $A_t$ constriction (versus the $A_0$ for stops shown in Figure 3–13 above).

### 3.2.2.1.2 Comparison with Bakovic (1994)

It is useful now to compare the aperture-theoretic representations in (3.6) with those proposed by Bakovic (1994), whose analysis was examined in Section 2.2.5 of Chapter 2. The representations are shown in Figure 3–14:

![Figure 3–14: Comparison of aperture-theoretic representations of coronal tap and trill](#)

The representations proposed here differ from those of Bakovic in several respects. One crucial difference is that the representations of the tap as a single $A_m$ and of the trill as a plosive $A_0A_m$ sequence do not directly reflect the articulatory properties of these segments. In Section 3.1, the tap was shown to involve a ballistic gesture consisting of approach, constriction, and release phases. Similarly, the trill does not have complete
closure like a plosive, but rather it is an articulatory posture of intermediate stricture between fricatives and stops upon which passive vibrations are aerodynamically imposed.

Furthermore, Bakovic's representations do not capture the formal symmetry between lenition and fortition processes as spreading and delinking, respectively. In Section 3.2.2.1.1, lenition was argued to result from the bidirectional spreading of aperture values of approximant or greater, which derives the contour representation of the tap from an underlying stop or trill. Conversely, fortition results from the delinking of a peripheral aperture position, which permits an increase in the duration of the central constriction. In contrast, Bakovic's analysis views lenition and fortition as the underparsing and insertion, respectively, of an $A_0$ closure position. However, as argued above, the aperture configurations resulting from underparsing and insertion, namely $A_0$ and $A_0A_m$, respectively, do not reflect the articulatory properties of tap and trill segments.

Having motivated the articulatory representations of the coronal tap and trill in (3.6), I now turn to a discussion of constraints on the aperture structure of these rhotics.

### 3.2.2.2 Constraints on Coronal Transitions

The peripheral $A_m$ nodes of the tap in (3.6a) function as articulatory transitions between the central $A_t$ constriction and the aperture specifications present in the surrounding segmental context. I argue that the presence of $A_m$ in coronal articulations is penalized by
*FAST constraints, which dislike rapid transitions.\textsuperscript{33} The context-free *FAST constraint in (3.10) encodes a general preference for the single position of the alveolar trill over the tripartite aperture contour of the alveolar tap:

\begin{equation}
\text{(3.10)} \quad \ast \text{FAST} \\
\text{Avoid faster-than-usual articulatory transitions in constrictions involving the tongue tip}
\end{equation}

\[ \begin{array}{c}
\checkmark & r & \ast & r \\
\text{cor} & \text{cor} & \text{cor} \\
A_t & A_m A_t A_m
\end{array} \]

The tap is additionally penalized by two positional FAST constraints, one targeting Place-sharing configurations and the other phrase-initial position. These constraints are motivated in the following sections.

### 3.2.2.2.1 Place/stricture-sharing in Homorganic Clusters

As previously mentioned, it is assumed that stricture is dominated by Place in the feature geometry (Padgett 1994, 1995). This is demonstrated by the fact that the coronal place node dominates the aperture nodes in the representations of the tap and trill in (3.6). The benefit of this assumption is that it allows formal capture of the obligatory neutralization to trill in homorganic clusters in languages such as Kairiru, Ngizim, and those of the

\textsuperscript{33} The context-free *FAST constraint in (3.10) is taken from Steriade (1995a), but the context-specific *FAST/SAME SITE in (3.11) and *FAST/INITIAL in (3.15) originate with the present account.
Iberian Romance family (see Section 1.1 of Chapter 1). The *FAST/SAME SITE constraint in (3.11) bans the rapid $A_m$ approach phase when it intervenes between two aperture positions of greater stricture under the same Place node. (N.B.: Place-sharing in homorganic clusters is denoted by the $\alpha_{Place}$ subscript.)

\[
\text{(3.11) \hspace{1cm} *FAST/SAME SITE} \\
\text{Avoid faster-than-usual articulatory transitions in Place-sharing clusters involving the tongue tip}
\]

\[
\begin{align*}
\checkmark [\text{nr}]_{\alpha_{Place}} & \quad * [n^\gamma r]_{\alpha_{Place}} & \text{cf. } [p^\gamma r] \\
\text{\begin{tikzpicture}[baseline=-0.5ex]
\node (c) at (0,0) {cor};
\node (a) at (1,0) {cor};
\node (l) at (1,1) {lab};
\node (r) at (1,2) {cor};
\draw (c) -- (a); 
\draw (a) -- (r); 
\draw (l) -- (a); 
\end{tikzpicture}} & \text{\begin{tikzpicture}[baseline=-0.5ex]
\node (a) at (0,0) {A_0A_t};
\node (m) at (1,0) {A_0A_mA_tA_m};
\end{tikzpicture}} & \text{\begin{tikzpicture}[baseline=-0.5ex]
\node (a) at (0,0) {A_0A_mA_tA_m};
\end{tikzpicture}}
\end{align*}
\]

When a rhotic surfaces next to a consonant with which it shares Place, *FAST/SAME SITE will ensure neutralization to trill. If the rhotic and adjacent consonant have separate Place nodes, as in the heterorganic [p$^\gamma$ r] cluster shown above, then the intervening $A_m$ transition is not penalized by the constraint in (3.11).

The claim that Place-sharing prohibits an articulatory transition between homorganic consonants finds precedence in Clements' (1985) analysis of consonantal transition phenomena in Sierra Popoluca, a Zoquean language spoken in Mexico (Elson 1947, 1956; Foster and Foster 1948). Consonant clusters in this language are realized with an intervening open transition if the consonants are heterorganic, while homorganic clusters lack such a transition, as shown in (3.12):
In (3.12a), the open transition is realized as aspiration after the voiceless velar stop and as a short schwa-like vowel after the palatal nasal. The homorganic sequences of [k.g] and [ŋ.k] in (3.12b) lack an open transition.

Clements analyzes the open transition as an oral release feature, represented by a 'floating' occurrence of the feature [+continuant]. Specifically, the rule in (3.13) inserts this feature between two stops:

(3.13)  Ø → [+cont] / [–cont] __ [–cont]

The application of this rule generates surface forms such as [kɛk [+cont]pa?] and [miŋ [+cont]pa?], and the realization of [+cont] as voiceless or voiced is assumed to be the result of universal phonetics. The rule fails to apply in the homorganic clusters of (3.12b), however, because these consonants are linked to the same Place node. To see this, consider the geometric representations of heterorganic [kp] and homorganic [kg] in (3.14). (N.B.: In accordance with Padgett's (1994, 1995) proposal regarding Place/stricture dependency, I adapt Clements' original formalism by depicting [cont] features as dependent on the Place node.)
(3.14) Place/stricture-sharing in homorganic consonant clusters (adapted from Clements 1985)

Manner tier: 

Supralaryngeal tier: 

Place tier: 


[kp] [kg]

In heterorganic clusters such as [kp], the two consonants have independent Place nodes. On the other hand, the identity of Place specifications in homorganic clusters such as [kg] is represented by the fact that these consonants are both linked to the same Place node. The shared Place node in turn dominates a single [–cont] specification, on the assumption that the merger of identical nodes also entails the merger of identical dependent features. This is the explanation for why [+cont] may be inserted in [kp] but not in [kg]: only the former cluster meets the structural description of rule (3.13).

Although both Clements' analysis and the *FAST/SAME SITE constraint proposed in (3.11) ensure the absence of release in homorganic clusters, the two approaches differ with respect to the representation of stricture. While Clements assumes the binary feature [continuant], the present account represents stricture in terms of aperture positions. The

34 See the Shared Features Convention of Steriade (1982) and Clements' (1985) reformulation of it under different feature-geometric assumptions.
shared Place node of the homorganic [kʁ] cluster in (3.14) dominates a single [–cont] feature. The merger of [–cont] specifications under Place is crucial in blocking the release insertion rule, which requires flanking values of [–cont] for its application. This contrasts with the aperture-theoretic representation of the homorganic [nɾ] cluster in (3.11), which dominates an A₀Aᵣ sequence. The aperture positions for the nasal and the rhotic are different, so they fail to merge. The constraint *FAST/SAME SITE simply forbids an intervening Aᵣ from appearing between two positions of greater stricture (e.g., A₀ and Aᵣ) under the same Place node. The trill is obligatory under Place/stricture-sharing configurations because it lacks the marked Aᵣ transition.

### 3.2.2.2.2 Phrase-initial Fortition

The other positional constraint on articulatory transitions in coronal constrictions is

*FAST/INITIAL, which disfavors the initial Aᵣ position of the tap in phrase-initial position, as seen in (3.15):

(3.15)  *FAST/INITIAL

Avoid faster-than-usual articulatory transitions in phrase-initial constrictions involving the tongue tip

\[
\begin{align*}
\text{cor} & \quad \text{cor} \\
Aᵣ & \quad AᵣAᵣAᵣAᵣ
\end{align*}
\]

This constraint mandates that phrase-initial coronal consonants should not begin with an Aᵣ aperture position and thus prefers the Aᵣ position of the trill. (3.15) is a specific
instantiation of the more general phenomenon of articulatory strengthening in initial
position. Keating et al. (1999) have demonstrated a cross-linguistic tendency for lingual
articulations to exhibit an increase in closure duration and extent of contact in domain-
initial positions, especially at the beginning of an utterance. The *FAST/INITIAL constraint
is the formal expression of phrase-initial fortition with respect to coronal constrictions.
By prohibiting the initial A_in position of the tap, it prefers the longer A_t constriction of the
trill, which allows passive vibration of the tongue tip to occur under an applied airstream.

3.2.2.3 Constraint on Coronal Constrictions

The final articulatory markedness constraint necessary in the present account is *HOLD,
shown in (3.16). This constraint prefers the shorter A_t constriction of the tap to the longer
one of the trill.

35 Other examples of initial fortition in Spanish include the failure of phrase-initial voiced
stops [b,d,g] to undergo spirantization and the presence of glottal stop before word-initial
vowels in the same context. The fact that bilabial and velar voiced obstruents are also
strengthened in phrase-initial position suggests that initial fortition may stem from a
constraint more general than *FAST/INITIAL in (3.15), which targets only coronal
articulations. I will not pursue this possibility here, but see Bakovic (1994) for relevant
discussion and analysis under different theoretical assumptions.

36 See Figure 3–12 and the surrounding discussion, in which differences in the
constriction duration of the tap versus trill were argued to follow as a consequence of
universal phonetics.
Cross-linguistic evidence suggests that the longer constriction of the trill is more marked in some positions than in others. First, as noted previously in Section 3.2.2.1.1.1, intervocalic position is a typical cross-linguistic lenition environment in which the stops and trills tend to undergo a reduction in duration. In other words, there is greater impetus for constrictions to lenite between vowels than in other environments. With respect to intervocalic position, Kirchner (1998) argues the following: "All else being equal, lenition is more likely to occur the more open the segments which flank the target… lenition occurs more readily in [intervocalic] contexts … because greater effort is required to achieve a given constriction target…” (179). Second, the phonetic studies of Inouye (1995) reveal that trills are especially prone to reduced duration in postconsonantal contexts. Romanian, Lithuanian, Icelandic, Lugbara, and Indonesian all posses a single coronal trill in their phonological inventories. Measurements of the duration and number of lingual contacts of the trill in these languages show a clear tendency for lenited allophones to surface postconsonantally (see Inouye 1995:245-255).

The common property of intervocalic and postconsonantal contexts is that they are both prevocalic contexts. The greater impetus to reduce the duration of coronal trills in prevocalic (i.e., intervocalic and postconsonantal) position can be captured by having *HOLD evaluate the duration of the $A_t$ constriction more stringently for trills surfacing
before vowels. Therefore, I assume that this constraint assigns two violation marks to a trill when it surfaces in prevocalic position versus one mark when it surfaces elsewhere, as shown in (3.17):³⁷

(3.17) *HOLD is violated twice by the longer $A_t$ constriction of trill in prevocalic positions, but once in non-prevocalic positions

$$
\begin{align*}
** \text{V}_{rV} & \quad \quad \text{*V}_{rp} & \quad \quad \text{*V}_{r\parallel} \\
\text{cor} & \quad \text{lab} \quad \text{cor} & \quad \text{cor} \quad \text{lab} & \quad \text{cor} \\
A_v & \quad A_t & \quad A_v \quad A_0 A_m & \quad A_v & \quad A_t \quad A_0 A_m & \quad A_v & \quad A_t
\end{align*}
$$

The aperture-theoretic representations that *HOLD favors are shown in (3.18):

³⁷ Another way to guarantee such stringency effects is to tease apart a positional variant of the *HOLD constraint targeting prevocalic contexts—a move similar to that taken above with respect to the context-specific *FAST/INITIAL and *FAST/SAME SITE versus context-free *FAST. Under a ranking such as *HOLD/\_V » *HOLD, *HOLD/\_V would guarantee prevocalic taps, while the domination of lower-ranked *HOLD by CONTRAST(dur) or *FAST would yield contrast or neutralization to trill, respectively, in non-prevocalic positions. However, this approach creates a potential problem with respect to capturing the implicational relation among contrastive positions, shown in (3.4). Specifically, nothing rules out the possibility of a ranking such as *HOLD/\_V » CONTRAST (dur/V\_V) » CONTRAST(dur/#_V) » CONTRAST(dur) » {other markedness constraints}, which would neutralize contrast to tap between vowels and word-initially while allowing contrast elsewhere. This is an undesirable result insofar as all of the languages surveyed maintain tap/trill contrast at least intervocalically. Nonetheless, some principled motivation must be found for the fact that *FAST seems to admit positional variants while *HOLD cannot. I leave this issue for future research. Thanks to Eric Bakovic and Richard Page for discussion on this matter.
As shown in (3.18), this constraint favors the contour representation of the tap by ensuring the association of the rhotic's Place node to an adjacent \( A_v \) or \( A_m \) position. In contrast, the trills in (3.17) are all single \( A_t \) positions. In representational terms, the lack of an association line between the rhotic's Place node and a following \( A_v \) is more marked than the lack of association to a preceding \( A_v \) position. This directional asymmetry may derive from a greater preference for consonantal articulations to have a release phase than an approach phase when either is potentially available via association to an adjacent vowel.\(^{38}\) Whatever the motivation is for this asymmetry, its effects are appropriately reflected by the extra violation of \(^{*}\text{HOLD}\) when trills are prevocalic.\(^{39}\) In Section 3.3.3, the assumption regarding the double violation of \(^{*}\text{HOLD}\) is shown to be crucial in

\(^{38}\) This is admittedly a speculative possibility, although it is vaguely reminiscent of Steriade's (1993:404) release projection rule, which ensures that \( A_0 \) plosives universally project an \( A_m \) release position. In other words, the preference for plosives to have a following release mirrors the preference for \( A_t \) rhotics to associate to a following vowel.\(^{39}\) Richard Page (personal communication) raises an important issue regarding the stringency of \(^{*}\text{HOLD}\) with respect to prevocalic trills. Specifically, this claim would seem to entail the unlikely pattern that trills should be more common cross-linguistically in word-final position than in word-initial position in languages that permit coda consonants. The entailment does not hold, however, given that there is another constraint, \(^{*}\text{FAST/INITIAL}\), which may be ranked above \(^{*}\text{HOLD}\). The ranking of \(^{*}\text{FAST/INITIAL} \gg \text{*HOLD}\) would ensure trills in word-initial prevocalic contexts but still allow taps to occur in word-final position, assuming, of course, that context-free \(^{*}\text{FAST}\) ranks below \(^{*}\text{HOLD}\).
accounting for neutralization to tap after heterorganic consonants and in word-final prevocalic position in Spanish and Catalan.

3.3 Analysis of Spanish Rhotics

The remaining sections of this chapter illustrate how the Spanish pattern is accounted for by the phonetically-based OT analysis developed above. Relevant data from other Iberian Romance languages are taken into consideration as necessary. The analysis is then compared with existing prosodic accounts in Section 3.3.5.

Table 3–2 below presents a summary of the Spanish pattern, using examples from the data presented in Chapter 2. Shaded cells in the center column denote positions of contrast neutralization. The realization of rhotics in each position is accounted for in the following sections, in which I provide constraint evaluations to justify the necessary rankings.
Table 3–2: Rhotic distribution in Spanish

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td>$pe[r]o$ 'but', $pe[r]o$ 'dog'</td>
</tr>
<tr>
<td>After homorganic consonant</td>
<td>trill</td>
<td>$hon[r]a$ 'honor', $al[r]ededor$ 'around', $Is[r]ael$ 'Israel'</td>
</tr>
<tr>
<td>Phrase-initial</td>
<td>trill</td>
<td>$[</td>
</tr>
<tr>
<td>Word-initial intervocalic</td>
<td>tap</td>
<td>$la [r]osa$ 'the rose', *$la [r]osa$</td>
</tr>
<tr>
<td>After heterorganic consonant</td>
<td>tap (trill only in highly emphatic speech)</td>
<td>$t[r]es$ 'three', $b[r]azo$ 'arm', $c[r]ea$ 's/he creates'</td>
</tr>
<tr>
<td>Before any consonant</td>
<td></td>
<td>$ma[r ~ r]tes$ 'Tuesday', $ma[r ~ r] verde$ 'green sea'</td>
</tr>
<tr>
<td>Phrase-final</td>
<td></td>
<td>$ma[r ~ r</td>
</tr>
<tr>
<td>Word-final intervocalic</td>
<td>tap</td>
<td>$ma[r] azul$ 'blue sea', *$ma[r] azul$</td>
</tr>
</tbody>
</table>

### 3.3.1 Intervocalic Contrast

In Spanish, the tap and trill are phonologically contrastive between vowels because $\text{CONTRAST(dur/V\_V)}$ outranks the two markedness constraints with which it interacts, namely $\text{*HOLD}$ and $\text{*FAST}$, as shown in tableau (3.19):
(3.19) Maintenance of intervocalic contrast

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. VrV ≠ VrV</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. VrV</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. VrV</td>
<td>!</td>
<td>**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The neutralizing candidates (3.19b,c) fail to maintain rhotic contrast in word-medial intervocalic position and are ruled out by CONTRAST(dur/V\_V). The winning candidate is (3.19a) because the tap and trill are contrastive between vowels, satisfying the highest-ranked constraint.

Some comments are in order with respect to the nature of the candidates being evaluated in tableau (3.19). An important research goal for Dispersion Theory is to further refine our understanding of what candidates are and how they are evaluated in a theory that assumes no underlying representation.40 Here, I follow Flemming (1999) and Ní Chiosáin and Padgett (2001) in assuming that candidates are idealized, possible surface forms of languages. Candidate (3.19a), therefore, expresses the generalization that two surface forms are contrastive in Spanish if they contain the sequences VrV and VrV, respectively, where the exact nature of V is irrelevant. Accidental gaps are, of course, possible. For example, *pero 'but' vs. *perro 'dog' constitute a minimal pair, but *acera 'pavement; sidewalk' cannot because the form *acerra is not an actual word in

40 Flemming's (1995) surface-oriented Dispersion Theory of contrast was discussed in Section 1.2.2.2 of Chapter 1.
Spanish, although a possible grammatical one. I shall continue to employ hypothetical, idealized candidate forms throughout the remainder of this dissertation, although on some occasions, actual words will need to be evaluated (see, for example, tableaux (4.13) and (4.22) in Chapter 4).

### 3.3.2 Neutralization to Trill

In non-intervocalic positions, the decision falls to the lower-ranked markedness constraints, which collectively favor the neutralization of contrast. In Spanish, high-ranked *FAST/SAME SITE and *FAST/INITIAL ensure trills after homorganic consonants and in phrase-initial position, respectively, as the following tableaux demonstrate. (N.B.: Place/stricture-sharing in homorganic clusters is denoted by the use of brackets.)

(3.20) Neutralization to trill in homorganic cluster

<table>
<thead>
<tr>
<th></th>
<th>*FAST/INITIAL</th>
<th>CONTRAST (dur/#_V)</th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. {C’r}V ≠ {Cr}V</td>
<td></td>
<td></td>
<td>*/!</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. {C’r}V</td>
<td></td>
<td></td>
<td>*/!</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. {Cr}V</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>
The ranking of *FAST/SAME SITE » *HOLD » CONTRAST(dur) predicts trills in homorganic clusters, as in (3.20c). Similarly, the ranking of *FAST/INITIAL » CONTRAST(dur/#_V) » *HOLD makes the same prediction for phrase-initial position, as in (3.21c). In each case, the trill is optimal because it lacks an A_m approach in a marked position.

The reader may have already noticed a potential problem in the analysis thus far with respect to initial fortition. Since *FAST/INITIAL specifically targets phrase-initial rhotics, how do we explain the fact that the trill is obligatory in any word-initial position at the phrasal level? In fact, the constraint ranking makes the wrong predictions regarding word-initial postvocalic and word-initial postconsonantal positions. Since *FAST/INITIAL has nothing to say about rhotics in these contexts, the top two constraints of the CONTRAST(duration) hierarchy incorrectly predict phonological contrast. The tableaux in (3.22) illustrate this problem:
(3.22) Rhotic duration contrast incorrectly licensed in word-initial postvocalic and word-initial postconsonantal positions

<table>
<thead>
<tr>
<th>Contrast (dur/V_V)</th>
<th>*Fast/Initial</th>
<th>Contrast (dur/#_V)</th>
<th>*Hold</th>
<th>*Fast</th>
<th>Contrast (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. V</td>
<td>rV V</td>
<td>≠ V</td>
<td>rV</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b. V</td>
<td>rV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. V</td>
<td>rV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>d. C</td>
<td>rV ≠ C</td>
<td>rV</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e. C</td>
<td>rV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>f. C</td>
<td>rV</td>
<td>*!</td>
<td></td>
<td>**</td>
<td>*</td>
</tr>
</tbody>
</table>

The analysis fails to account for the generalization that all word-initial rhotics at the phrasal level must be trills, regardless of the final segment of the previous word. A potential solution would require some mechanism for ensuring that the effects of phrase-initial markedness become generalized as word-initial effects. I develop such an account in the following sections.

3.3.2.1 Lexical Conservatism

Working on the basis of facts from English Level 2 phonology and French liaison, Steriade (1999b) proposes lexical conservatism as a class of grammatical conditions "promoting the use of pre-existing, familiar expressions, or parts or properties of such expressions" (244). A simple example involves stress in morphologically derived words
in English. The nonce word *aspiratory* \([\text{æsp}r\text{ɪ}t\text{ə}r\text{i}]\) with stress on the initial syllable would be seen as lexically related to *aspire*, while \([\text{əs}p\text{ɪ}r\text{ə}t\text{ə}r\text{i}]\) with stress on the second syllable would relate to *aspirate*, but not vice-versa. A lexical conservatism condition is argued to enforce similar stress configurations in lexically listed forms and novel forms. In the interpretation of the nonce words, English speakers employ phonological similarity to pre-existing words as a guide.

Several important theoretical issues arise with respect to lexical conservatism: What counts as a lexically listed form? How are lexical conservatism conditions to be expressed formally? What types of phonological properties are subject to these conditions? In Steriade (1999b), lexical conservatism guarantees phonological similarity between a morphologically derived word and its lexically listed base form, thereby creating uniform morphological paradigms, e.g., \{*aspire, aspiratory*\} and \{*aspirate, aspiratory*\}. Another type of paradigm is a set of phrases sharing the same word, such as \{*flower, the flower, the flower is a tulip, Mary picked a flower*\}. It is the phrasal paradigm that concerns us here. Specifically, I propose that phrasal paradigms are subject to lexical conservatism conditions which ensure phonological similarity between the phrase-level realization of a word and its lexically listed form.

### 3.3.2.1.1 Lexically Listed Forms

With respect to what counts as the lexically listed form of a word for the purposes of lexical conservatism in phrasal paradigms, I assume it to be the *citation form* of that
word, i.e., the form of the word as it is realized in isolation. Given a word such as 
\{\textit{flower}\}, lexical conservatism constraints may be posited to enforce similarity between 
the citation form of \{\textit{flower}\} and its realizations at the phrasal level with respect to a 
given phonological property. In other words, the citation form stands in correspondence 
with forms of the same word appearing across different phrase-level contexts, as 
demonstrated in (3.23):

(3.23) Correspondence relations between the citation/lexically listed form of 
\{\textit{flower}\} and its phrasal realizations

Citation/lexically listed form:  \{\textit{flower}\}

Phrasal realizations:    \{\textit{the flower}\}
    \{\textit{the flower is a tulip}\}
    \{\textit{Mary picked a flower}\}

The proposal to relate citation forms with their phrase-level realizations via 
correspondence constraints is not new. In her discussion of retroflexion in apical 
consonants in Sanskrit, Steriade (1995a) observes that distinctive retroflexion is 
disallowed stem-internally after a consonant but maintained word-initially across 
different phrasal contexts—even after a consonant. According to her analysis,

"such discrepancies between the word-internal and the phrasal distribution 
of contrasts result from the effect of highly ranked correspondence 
constraints mandating that the retroflexion value of an apical be identical 
to the value displayed in the allomorph identifiable as the \textit{forme de} 
\textit{fondation} (Kurylowicz 1949) of the paradigm. Here we will equate the 
\textit{forme de fondation} with the isolation form. If the initial apical in the \textit{forme}
de fondation possesses distinctive retroflexion, then the same feature value is maintained throughout the paradigm, across contexts, i.e. even after consonants, in virtue of the correspondence constraints. If the morpheme-initial apical in the forme de fondation is neutralized, then the neutralized quality will be preserved across contexts, even after vowels” (30).

In connecting this analysis with the present proposal regarding lexical conservatism at the phrasal level, let us note that the notions of forme de fondation, citation/isolation form, and lexically listed form are essentially equivalent.

### 3.3.2.1.2 Lexical Conservatism Constraints

Having established the relevant correspondence relation between the citation/lexically listed form of a word and its phrasal instantiations, I now turn to the formal expression of lexical conservatism conditions. Specifically, I propose that lexical conservatism constraints on words at the phrasal level follow the schema in (3.24):

\[
\text{(3.24) Formulation of lexical conservatism (LEXP) constraints (adapted from Steriade 1999b:346)}
\]

Let T(W) be the form of a word W appearing under evaluation.
Let L(W) be the lexically listed form of W.
Let P be some phonological property.

Every instance of P in L(W) is conserved in T(W).

At first glance, the definition of LEXP constraints in (3.24) is highly reminiscent of the featural input-output correspondence constraint of McCarthy and Prince (1995), which I repeat below for comparison:

\[
\text{(3.25) IDENT–IO(F)}
\]

Output correspondents of an input [γF] segment are also [γF].
The faithfulness constraint $\text{IDENT–IO}(F)$ in (3.25) ensures that underlying specifications for some feature $F$ will surface faithfully in the output.\footnote{See the discussion of Correspondence Theory in Section 1.2.2.1 of Chapter 1.}

There are non-trivial differences between $\text{LEXP}$ constraints and $\text{IDENT–IO}(F)$, however. First, the lexically listed form $L(W)$ to which $\text{LEXP}$ constraints make reference is not the same as the underlying or input form of $\text{IDENT–IO}(F)$ constraints. The correspondence relation that holds between $L(W)$ and $T(W)$ is essentially one of the output-output variety. That is, $L(W)$ is taken to be the surface realization of a word $W$ as it appears in isolation as opposed to an abstract, underlying input form. Similarly, $T(W)$ is the surface realization of word $W$ embedded within a specific phrasal context. From the perspective of input-output correspondence models, then, $L(W)$ and $T(W)$ both constitute "output" forms. That these two surface forms should be related via $\text{LEXP}$ constraints is congruent with other proposals in the Optimality-theoretic literature, e.g., Anti-allomorphy and Multiple Correspondence (Burzio 1994, 1997), Output-Output Correspondence (Benua 1995, 1997), Paradigm Uniformity (Flemming 1995; Steriade 1995a, 2000), and Uniform Exponence (Kenstowicz 1996, 1997).

Second, the set of phonological properties to which $\text{LEXP}$ constraints can potentially refer extends beyond those properties typically assumed under Correspondence-theoretic analyses. In the account developed here, I propose that the variable $P$ in the schematic formulation of $\text{LEXP}$ constraints in (3.24) can include the property of phonological contrast itself, or the absence thereof. That is to say, $\text{LEXP}$ constraints are capable of generalizing contrasts or neutralizations present in a lexically
listed form $L(W)$ to its phrasal instantiation $T(W)$. In contrast, the $\text{IDENT–IO}(F)$ constraint in (3.25) simply enforces identity to underlying feature values, regardless of whether $F$ participates in a phonological contrast. This difference is ultimately related to the fact that Dispersion Theory evaluates phonological contrasts directly among output forms, while input-output correspondence evaluates identity to particular feature values in the input form. The importance of this aspect of $\text{LEXP}$ constraints will be made clear in the analyses to follow, where rhotic duration contrasts and neutralizations are generalized from the lexically listed forms of words to realizations of these words at the phrasal level.

### 3.3.2.2 Lexical Conservatism Effects on Word-initial Rhotics

Following the schema in (3.24), I adopt the lexical conservatism constraint on rhotic duration in (3.26):

(3.26) **$\text{LEX}(\text{duration})$**

Given $T(W)$, the form of a word $W$ appearing under evaluation, and $L(W)$, the lexically listed form of $W$, the contrastive/neutralized quality of rhotic duration in $L(W)$ is conserved in $T(W)$.

In the present analysis, $\text{LEX}(\text{duration})$ guarantees that the contrastive or neutralized status of the tap and trill in lexically listed forms is generalized to their corresponding phrase-level forms. As anticipated in the discussion following tableau (3.22) in Section 3.3.2, this is precisely the type of mechanism required to ensure that the effects of phrase-initial markedness become generalized as word-initial effects, which I will demonstrate below.

Now, when a word appears in isolation, word-initial position is necessarily also phrase-initial—exactly the context in which $\ast \text{FAST/INITIAL}$ ensures neutralization to trill,
as shown in tableau (3.21) above. When ranked high enough, LEX(duration) generalizes
the lexically listed initial trill to all word-initial positions at the phrasal level. In Spanish,
LEX(duration) dominates the entire CONTRAST(duration) hierarchy, as shown in the
following tableaux. (N.B.: The lexically listed form L(W) is provided above the tableaux
as a convenient reminder of the property that LEX(duration) seeks to conserve in T(W), in
this case, neutralization to trill.)

(3.27) Lexical conservatism ensures neutralization to trill in word-initial postvocalic
and word-initial postconsonantal positions

L(W): rV = (3.21c))

<table>
<thead>
<tr>
<th></th>
<th>LEX (dur)</th>
<th>CONTRAST (dur/V_V)</th>
<th>*FAST/INITIAL</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. V</td>
<td>rV ≠ V</td>
<td>rV</td>
<td>*!</td>
<td></td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>b. V</td>
<td>rV</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. V</td>
<td>rV</td>
<td>*</td>
<td></td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>LEX (dur)</th>
<th>*FAST/INITIAL</th>
<th>CONTRAST (dur/#_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>d. C</td>
<td>rV ≠ C</td>
<td>rV</td>
<td>*!</td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e. C</td>
<td>rV</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>f. C</td>
<td>rV</td>
<td></td>
<td>*</td>
<td>**</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

In both evaluations, LEX(dur) assigns the same violation marks to candidates as

*FAST/INITIAL does in the evaluation of phrase-initial forms in tableau (3.21). Since
lexically listed, i.e., phrase-initial, forms exhibit neutralization to trill in word-initial
position, the ranking of LEX(dur) » CONTRAST(dur/V_V) » CONTRAST(dur/#_V) ensures
word-initial trills both postvocally in (3.27c) and postconsonantally in (3.27f). The functioning of LEX(dur) with respect to word-initial postvocalic position is formally illustrated in (3.28):

(3.28) LEX(duration) ensures that the neutralized status of word-initial trill in the lexically listed form L(W) is conserved postvocally in the phrasal form T(W):

```
L(W):                              \[ \| rV \]
     \[ \text{neutralization} \]
     \[ \text{to trill (3.21c)} \]

T(W):     * V|rV ≠ V|rV    * V|rV    √ V|rV
     \[ \text{contrast (3.27a)} \]  \[ \text{neutralization} \]
     \[ \text{to tap (3.27b)} \]    \[ \text{neutralization} \]
     \[ \text{to trill (3.27c)} \]
```

Only in candidate (3.27c) is the neutralized trill of lexically listed forms preserved at the phrasal level. The contrastive candidate (3.27a) and the neutralized tap candidate (3.27b) fail to conserve the lexically listed word-initial trill and, therefore, violate LEX(dur). The same formal relations expressed in (3.28) for word-initial postvocalic contexts are assumed to hold for word-initial postconsonantal contexts (3.27d–f) as well.

To summarize, *FAST/INITIAL is ultimately responsible for the absence of word-initial taps. LEX(dur) makes the phrase-initial trill an invariant word-initial property, even when the larger syntactic context might have otherwise licensed a rhotic duration contrast.
3.3.2.3 Word-initial Geminate Stops in Swiss German

In this section, I examine the patterning of word-initial geminate stops in Swiss German, which appears to pose problems for the LEX(duration) analysis developed above.\(^{42}\) Swiss German possesses word-initial geminate stops that surface phrase-medially but never phrase-initially or in citation forms. Steriade's Licensing-by-Cue framework offers a viable explanation for the neutralization of the singleton-geminate contrast in phrase-initial stops. If the primary phonetic correlate of geminate stops in Swiss German is closure duration, then it is plausible to think that the singleton-geminate distinction is neutralized in phrase-initial position, where stop closure is less perceptible, while the distinction is maintained phrase-medially, where the preceding syntactic context provides richer cues to stop closure duration.

The hypothetical tableau (3.29) below illustrates a possible analysis in accordance with the Dispersion-theoretic approach espoused in this dissertation. Here, I assume that the ranking of CONTRAST(duration\(_{\text{stop}/V_V}\)) » CONTRAST(duration\(_{\text{stop}}\)) encodes the greater perceptibility of closure duration of stops in intervocalic positions versus elsewhere (e.g., phrase-initially). For expository convenience, I take *GEMINATE to be a markedness constraint that prefers singleton consonants over their geminate counterparts. Finally, C and C\(_\backslash\) denote singleton and geminate stop consonants, respectively, in the candidates under evaluation.

\(^{42}\) Thanks to Richard Page for bringing this case to my attention and for motivating my attempts to provide a potential solution. I assume responsibility for any shortcomings in the proposed analysis.
(3.29) Maintenance of Swiss German singleton-geminate stop contrast between vowels, but neutralization to singleton stops in phrase-initial position

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur-stop/V__V)</th>
<th>*GEMINATE</th>
<th>CONTRAST (dur-stop)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. VCV ≠ VC:V</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. VCV</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c. VC:V</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td></td>
<td>CV ≠</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td></td>
<td>CV</td>
<td>*</td>
</tr>
<tr>
<td>f.</td>
<td></td>
<td>C:V</td>
<td>*!</td>
</tr>
</tbody>
</table>

Candidate (3.29a) best satisfies high-ranked CONTRAST(dur-stop/V_\_V) by maintaining the singleton-geminate contrast in intervocalic stops. This constraint is irrelevant in phrase-initial position, so lower-ranked *GEMINATE optimizes (3.29e) by neutralizing the singleton-geminate contrast to the singleton member of the pair.

While the cue-based account of degemination in Swiss German initial stops appears to be on the right track thus far, it becomes problematic with respect to word-initial phrase-medial contexts. Specifically, the assumption made in Section 3.3.2.1.1 that the lexically listed form of a word is equivalent to its citation form makes the incorrect prediction that all word-initial stops should be singletons. However, word-initial geminates do, in fact, surface in phrase-medial positions in Swiss German. To see this, let us assume the constraint in (3.30), which refers specifically to stop closure duration:

(3.30) \text{LEX(\text{duration}_\text{stop})}

Given T(W), the form of a word W appearing under evaluation, and L(W), the lexically listed form of W, the contrastive/neutralized quality of stop closure duration in L(W) is conserved in T(W).
On the assumption that $\text{LEX}(\text{duration}_{\text{stop}})$ outranks the $\text{CONTRAST}$ hierarchy for distinctive stop closure duration (cf. the tableaux in (3.27) above), tableau (3.31) illustrates the incorrect prediction of this ranking with respect to phrase-medial word-initial stops appearing after vowels:

(3.31) Degemination of Swiss German stops incorrectly predicted in word-initial postvocalic position

$L(W): CV = (3.29e)$

<table>
<thead>
<tr>
<th></th>
<th>$\text{LEX}(\text{dur}_{\text{stop}})$</th>
<th>$\text{CONTRAST}$</th>
<th>*$\text{GEMINATE}$</th>
<th>$\text{CONTRAST}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $V</td>
<td>CV \neq V</td>
<td>C:V$</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b. $V</td>
<td>CV$</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. $V</td>
<td>C:V$</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Since stops are neutralized to singletons in the lexically listed, i.e., phrase-initial, form in (3.29e), high-ranked $\text{LEX}(\text{dur}_{\text{stop}})$ has the ill effect of generalizing phrase-initial degemination to all word-initial positions at the phrasal level—contrary to the empirical facts.

Note that this problem is the exact opposite of that encountered in the analysis of obligatory word-initial trill in Spanish. In the tableaux in (3.22) above, it was shown that the $\text{CONTRAST}$ hierarchy for distinctive rhotic duration was incapable of ensuring neutralization to trill in word-initial postvocalic and postconsonantal positions at the phrasal level. $\text{LEX}(\text{duration})$ in (3.26) was proposed as a way to generalize phrase-initial trill—guaranteed by *$\text{FAST}/\text{INITIAL}$—to all word-initial positions. However, the case of initial geminate stops in Swiss German now seems to require the opposite results, namely...
that the singleton-geminate distinction be \textit{recovered} in phrase-medial contexts, despite its neutralization in phrase-initial position in (3.29e).

A potential solution to this paradox is available if we accept a fundamental distinction between stop duration and rhotic duration. With respect to the paradigmatic extension of sound properties, Steriade (2000) speculates that

"any sound property or any cluster of properties may give rise to paradigmatic leveling but that the categorical or variable nature of the effect will depend on the perceptibility of the property being generalized through leveling. The less perceptible the contrast generated in this way, the harder it will be to detect and enforce uniformity in each and every relevant token" (332).

It is plausible to think that the alveolar trill differs from a geminate stop with respect to the perceptibility of duration. While a geminate stop involves complete closure, the trill has an inherently salient acoustic structure consisting of vocalic formant values briefly interrupted by periods of stop-like silence (Widdison 1997:190).\textsuperscript{43} As a result, it is natural to expect a phrase-initial trill to be inherently more perceptible than a phrase-initial geminate stop because the internal durational cues are more salient in the former than in the latter segment type.

One possible account of the distinct behavior of word-initial trills in Spanish versus word-initial geminate stops in Swiss German is to posit a correlation between the ranking of \textit{Lex}(duration) constraints and the relative perceptibility of closure duration in each case. Since closure duration is inherently less perceptible in geminate stops than in trills, the lexical conservatism constraint on stop closure duration, \textit{Lex}(duration_{stop}), has a

\textsuperscript{43} See Section 3.1.2.1 on the perceptual properties of the alveolar trill and specifically \textit{Figure 3–9} and the surrounding discussion on its inherently salient acoustic structure.
lower ranking with respect to the $\text{CONTRAST}(\text{duration}_{\text{stop}})$ constraints.\footnote{See Steriade's (2001) P-map proposal for a similar although somewhat distinct analysis in which perceptibility conditions dictate the relative ranking of correspondence constraints.} Under this ranking, $\text{CONTRAST}(\text{dur}_{\text{stop}}/\text{V}_-\text{V})$ is now able to permit recovery of the singleton-geminate distinction when a preceding vowel at the phrase level provides the necessary acoustic cues. This solution is illustrated in tableau (3.32):

(3.32) Low ranking of LEX($\text{dur}_{\text{stop}}$) ensures recovery of singleton-geminate stop contrast in word-initial postvocalic position in Swiss German

L(W): CV (=\,(3.29e))

<table>
<thead>
<tr>
<th></th>
<th>$\text{CONTRAST}$ (dur\textsubscript{stop}/V\textsubscript{−}V)</th>
<th>*\text{GEMINATE}</th>
<th>$\text{CONTRAST}$ (dur\textsubscript{stop})</th>
<th>LEX(dur\textsubscript{stop})</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. V\vert CV ≠ V\vert C\vert V</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. V\vert CV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. V\vert C\vert V</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Since LEX($\text{dur}_{\text{stop}}$) is safely ranked below the $\text{CONTRAST}(\text{dur}_{\text{stop}})$ hierarchy, phrase-initial degemination is no longer obligatorily generalized from the lexically listed/citation form to all word-initial positions at the phrase level. $\text{CONTRAST}(\text{dur}_{\text{stop}}/\text{V}_-\text{V})$ successfully licenses the contrastive candidate in (3.32a) in accordance with the richer cues made available by the preceding word-final vowel. The reader may verify that the same ranking also accounts for phrase-initial degemination in (3.29e) above.

To sum up, the constraint reranking solution developed here successfully explains the distinct behavior of Spanish trill versus Swiss German geminate stops in word-initial positions.
position. Therefore, the Swiss German data do not constitute counterevidence to the proposal that the lexically listed form of a word is equivalent to its citation form.45

3.3.3 Neutralization with Variation

In Spanish, the contrast between the tap and trill is neutralized to tap after heterorganic consonants, although the trill may surface in highly emphatic speech. Before any consonant and word-finally, contrast is neutralized with variation between the tap and trill as a function of speech style. (Refer to Table 3–2 for sample data illustrating these patterns.) Absence of contrast in these positions stems from the fact that context-free *HOLD and *FAST both outrank context-free CONTRAST(dur). Specifically, the appearance of the tap after heterorganic consonants stems from the fact that *HOLD evaluates a trill more stringently when it surfaces before vowels (for the reasons discussed in Section 3.2.2.3). Variable realization in preconsonantal and word-final contexts is predicted by the fact that *HOLD and *FAST are left unranked with respect to one another.46 As a

---

45 This statement should be tempered with the caveat that further research is required to verify the broader range of empirical predictions made by such an analysis. Furthermore, a similar account may also provide an explanation as to why Spanish voiced obstruents harden to stops [b,d,g] in phrase-initial position but are realized as continuants [β,δ,ɣ] in word-initial postvocalic contexts (Harris 1969, Hualde 1989). I will not pursue this here, but see Bakovic (1994) for an existing proposal involving distinct theoretical assumptions.

46 Reynolds (1994) develops a theory of "floating constraints" to account for facts of variation within speech communities (cf. also Anttila 1997, Anttila and Cho 1998, Kang 1997, Nagy and Reynolds 1997, inter alia). According to this theory, the grammar comprises a single constraint hierarchy in which constraints governing the effects of variation are ranked relative to some constraints but not others. In the present analysis of Spanish rhotics, *HOLD and *FAST both rank higher than CONTRAST(duration) but are
result, either rhotic may surface non-contrastively. Evaluations are shown in tableau (3.33):

(3.33) Neutralization to tap after heterorganic consonants, but variation before any consonant and phrase-finally in Spanish

<table>
<thead>
<tr>
<th></th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $C^rV \neq CrV$</td>
<td>**!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. $C^rV$</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. CrV</td>
<td>**!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d. $V^rC \neq VrC$</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>e. $V^rC$</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f. VrC</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>g. $V^r| \neq Vr|$</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>h. $V^r|$</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>i. Vr|</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Since *HOLD is violated twice by prevocalic trill, candidate (b) is preferred over candidates (a) and (c) because it has the fewest combined violations of the unranked constraints *HOLD and *FAST. In preconsonantal and phrase-final contexts, however, these two constraints rule out contrastive candidates (d) and (g). The remaining candidates have the same number of violations of markedness and lower-ranked CONTRAST(dur). Since the constraints fail to rule out neutralization candidates (e,f) and (h,i), they are, therefore, equally optimal. Together, the constraint ranking ensures the tap after heterorganic consonants, but variation before consonants and pause.

unranked with respect to each other. See Morris (1998) for an analysis of stylistically-controlled variation in Spanish phonology using partially-ranked, floating constraints.
As discussed in Section 2.1 of Chapter 2, Morales-Front (1994:167) observes that the trill can surface in complex onsets in Spanish under conditions of highly emphatic speech (e.g., ¡inc[ɾ]eibles p[ɾ]ecios! ‘incredible prices!’). This is accounted for on the assumption that on such occasions, speakers momentarily fix the ranking between context-free markedness such that *FAST comes to dominate *HOLD, as shown in tableau (3.34):

(3.34) Trill surfaces in clusters and phrase-finally under highly emphatic speech conditions in Spanish

<table>
<thead>
<tr>
<th></th>
<th>*FAST</th>
<th>*HOLD</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. C^rV ≠ CrV</td>
<td>*</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b. C^rV</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c. CrV</td>
<td></td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>d. Vr^C ≠ VrC</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>e. Vr^C</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
| f. VrC | | *| *
| g. Vr^|| ≠ Vr^| | *| | |
| h. Vr^| | *| | *| |
| i. Vr^| | *| | *| |

The observation made by Harris (1983:144, Fn. 14) that a trill in /Cr/ onsets is not representative of normal speech styles is captured by the fact that *HOLD and *FAST are usually unranked in Spanish, as in (3.33). Only in highly emphatic speech mode is *HOLD temporarily demoted below *FAST, as in (3.34). In sum, the possibility of trills after heterorganic consonants in (3.34c) stems from the fact that *FAST may fall into a
categorical ranking relation with respect to *HOLD, i.e., *FAST » *HOLD, whereas these two constraints are otherwise unranked, i.e., { *HOLD, *FAST }, in normal speech styles.

The realization of rhotics in consonant clusters deserves further commentary. In tableau (3.20) above, rhotics neutralize to trill after homorganic (i.e., alveolar) consonants because *FAST/SAME SITE ensures the absence of an intervening Am position in Place/stricture-sharing configurations. Since the clusters in (3.33a–c) do not share Place, *FAST/SAME SITE is irrelevant with respect to rhotics appearing after heterorganic consonants. The decision falls to the freely-ranked markedness constraints *HOLD and *FAST, which collectively favor the tap, as shown in (3.33b). The representations of homorganic and heterorganic clusters optimized by this ranking are contrasted in (3.35):

(3.35) Trill after homorganic consonants versus tap after heterorganic consonants

a. [nr] αPlace  cf. *[n^r] αPlace  b. [t^r]

The behavior of preconsonantal rhotics differs from that of rhotics in postconsonantal position. In Spanish and in those dialects of European Portuguese that have an alveolar trill, the alveolar tap can surface before other alveolar consonants, as illustrated by the examples in (3.36):
Tap surfaces before alveolar and non-alveolar consonants in Standard Spanish and European Portuguese

a. Standard Spanish
   ca[r ~ r]ne  'meat'
   ba[r ~ r]co  'boat'

b. European Portuguese (Mateus and Andrade 2000)
   o[r]nar  'to adorn' (p. 59)
   a[r]co  'arch, arc' (p. 15)

Why is the alveolar trill obligatory after other alveolar consonants (e.g., Spanish honra 'honor', alrededor 'around', Israel 'Israel') but not before other alveolar consonants, as seen in (3.36a,b)? Since I have argued that consonants of homorganic clusters share Place and stricture in the feature geometry, one would expect neutralization to trill both before and after other alveolar consonants.47

A logically possible explanation for the variable appearance of the alveolar tap before any consonant in Spanish (3.36a) is that sequences of rhotic + consonant do not constitute Place/stricture-sharing configurations, even when the consonant is itself alveolar. The representations of preconsonantal rhotics in Spanish are shown in (3.37):

(3.37) No Place/stricture-sharing in any rhotic + consonant cluster

a.  [r’n]  ~  [r’n]  
    
    cor  cor  cor
    A_0  A_m A_m 

b.  [r’k]  ~  [rk]

   cor  dor
   A_0 A_m A_t A_0 

47 Thanks to Carlos Piñeros for raising the issue of taps before homorganic consonants.
Motivation for the difference between the representations in (3.35a) and (3.37a) may be found in independent but related facts involving Place assimilation. Among the sonorants appearing in preconsonantal position in Spanish, nasals and laterals typically assimilate in Place to the following consonant while rhotics do not (Harris 1969, 1984a,b; Hualde 1989). If assimilation is assumed to result in the Place-sharing configuration of (3.35a), then the fact that preconsonantal rhotics do not undergo assimilation correlates well with the independence of Place nodes in rhotic + consonant clusters, as shown in (3.37a,b). *\textit{FAST/SAME SITE} has nothing to say about these consonant clusters since they all have independent Place nodes. As a result, the tap and trill vary before all consonants in Spanish due to the partial ranking of *\textit{HOLD} and *\textit{FAST} over CONTRAST(dur).

In European Portuguese dialects with alveolar trills, however, no variation is reported before consonants (Mateus and Andrade 2000:15). Rather, neutralization to tap is obligatory in preconsonantal position, as shown in (3.36b). This can be explained by the fact that European Portuguese ranks *\textit{HOLD} above *\textit{FAST} and CONTRAST(dur). On the assumption that rhotic + consonant sequences are not Place/stricture-sharing configurations, this ranking ensures the tap before any consonant, as shown in tableau (3.38):

\begin{table}
\begin{tabular}{|c|c|c|}
\hline
Consonant & Tap & Trill \\
\hline
Consonant & & \\
\hline
\end{tabular}
\end{table}

\footnote{To be sure, an explicit account is necessary in order to explain the failure of rhotics to undergo Place assimilation in preconsonantal position. I shall not attempt an exhaustive analysis here. However, it should be noted that relative perceptibility is most likely a significant factor. It may be that nasals and laterals assimilate more readily because they lack an audible release and are, therefore, less perceptible with respect to Place in preconsonantal position. On the other hand, rhotics are more perceptible—and consequently less prone to assimilation—due to the posited \(A_m\) release position of the tap and the inherently salient acoustic structure of the \(A_t\) trill (see Section 3.1).}
Neutralization to tap in preconsonantal position in European Portuguese

<table>
<thead>
<tr>
<th></th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. VrC ≠ VrC</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. VrC</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. VrC</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

High-ranking *HOLD penalizes the longer Aₜ constriction of the trill in candidates (3.38a,c) and favors the shorter Aₜ constriction of the tap in (3.38b).

The realization of clusters in Catalan is similar to the realization of those in Spanish. Most researchers claim that only the trill appears before a consonant in Catalan (Barnils 1933:97, Hualde 1992:374, Mascaró 1978:48, Wheeler 1979:191-2). Badia (1965:277-84), however, attests to preconsonantal tap. Recasens (1991:326-8) represents the middle ground in observing a very short syllable-final trill of variable length and tension, depending on speech rate and other factors. I interpret these empirical reports as evidence that Catalan, like Spanish, exhibits neutralization with variable realization before any consonant. With respect to postconsonantal positions, the trill appears after alveolar consonants, while the tap appears after heterorganic ones. To my knowledge, no variation has been reported in the latter context. The overall distribution of the tap and trill in Catalan clusters is summarized in (3.39):
Distribution of tap and trill in Catalan clusters

a. Neutralization to trill after homorganic C
   hon[r]a       'honor'
   fol[r]o       'lining'
   Is[r]ael      'Israel'

b. Neutralization to tap after heterorganic C
   [pr]ometre    'to promise'
   [tʃ]es       'three'
   [kr]eu       'cross'

c. Neutralization with variation before any C
   ca[r ~ r]n   'meat'
   ca[r ~ r]bó  'coal'

This pattern suggests that like Spanish, Catalan has a partial ranking between
*HOLD and *FAST, which both dominate CONTRAST(dur). While the higher-ranking
*FAST/SAME SITE predicts neutralization to trill after homorganic consonants in (3.39a),
*HOLD and *FAST collectively ensure neutralization to tap after heterorganic consonants
in (3.39b) and neutralization with variation before any consonant in (3.39c). Tableau
(3.40) illustrates how the constraints account for the behavior or rhotics in Catalan
clusters:
(3.40) Neutralization to trill after homorganic consonants, tap after heterorganic consonants, and variation before any consonant in Catalan.

<table>
<thead>
<tr>
<th></th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. {C\textsuperscript{r}V} ≠ {C}V</td>
<td>*!</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. {C\textsuperscript{r}V}</td>
<td>*!</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. {Cr}V</td>
<td>**</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d. C\textsuperscript{r}V ≠ CrV</td>
<td>**!</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. C\textsuperscript{r}V</td>
<td>**!</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. CrV</td>
<td>**!</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. V\textsuperscript{r}C ≠ VrC</td>
<td>*</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. V\textsuperscript{r}C</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. VrC</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The above ranking ensures the trill after consonants with which it shares Place, as shown by the optimal (3.40c). Since lower-ranked *HOLD penalizes the trill more stringently in prevocalic position than before other segments, rhotics neutralize to tap after heterorganic consonants in (3.40e).\textsuperscript{49} In preconsonantal position, the partial ranking of *HOLD and *FAST results in neutralization with variation by ruling out the contrastive candidate (3.40g). Since (3.40h,i) tie on the remaining constraints, both the tap and trill are predicted to be possible variants in this context.

\textsuperscript{49} The putative absence of trills after heterorganic consonants suggests that Catalan normally maintains the free ranking between *HOLD and *FAST. If the effects of emphatic strengthening were to be attested in this position, however, then the same account proposed for Spanish in (3.34) may be readily invoked for Catalan.
3.3.3.1 Lexical Conservatism Effects on Word-final Rhotics

As was shown in tableau (3.33), the ranking of *HOLD, *FAST » CONTRAST(dur) predicts neutralization with variation between the tap and trill in phrase-final position in Spanish. The same ranking also makes the correct prediction for word-final preconsonantal position, as illustrated in tableau (3.41):

(3.41) Neutralization with variation correctly predicted in word-final preconsonantional position in Spanish

<table>
<thead>
<tr>
<th></th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vr</td>
<td>C ≠ Vr</td>
<td>C</td>
<td>*</td>
</tr>
<tr>
<td>b. Vr</td>
<td>C</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c. Vr</td>
<td>C</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Since there are no higher-ranking constraints that target word-final position, the context-free markedness constraints collectively favor non-contrastive variation word-finally before a consonant-initial word at the phrasal level.

With respect to word-final prevocalic position, however, the highest-ranked CONTRAST(dur/V_V) constraint once again makes the incorrect prediction that the tap and trill should contrast. This is the same problem that we saw regarding word-initial postvocalic rhotics in (3.22a). Tableau (3.42) illustrates the word-final prevocalic case:
175

Rhotic duration contrast incorrectly licensed in word-final prevocalic position

<table>
<thead>
<tr>
<th>CONTRAST (dur/V_−V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vr[V ≠ Vr[V</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. Vr[V</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. Vr[V</td>
<td>*!</td>
<td>**</td>
<td>*</td>
</tr>
</tbody>
</table>

This result runs counter to the empirical observation that word-final rhotics are neutralized to tap when the following word begins with a vowel (e.g., ma[r] azul vs. *ma[r] azul 'blue sea').

A solution comes once again in the form of lexical conservatism. Recall our assumption that the lexically listed form of a word is equivalent to its realization in isolation. Since the final segment of a word occurring in isolation is necessarily a phrase-final (i.e., prepausal) one, we should expect both the tap and trill to be possible in the word-final position of lexically listed forms. To make this point clear, I repeat the relevant portion of tableau (3.33) in tableau (3.43) below:

<table>
<thead>
<tr>
<th>CONTRAST</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vr^r</td>
<td></td>
<td>Vr</td>
<td></td>
</tr>
<tr>
<td>b. Vr^r</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c. Vr^r</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

The contrastive candidate (a) is ruled out because it has a greater number of collective violations of high-ranked markedness constraints than its competitors. Since the
remaining candidates (b) and (c) receive the same number of violations of markedness and lower-ranked CONTRAST(dur), they are both equally optimal. The result of this ranking is neutralization with variable realization in phrase-final position. If the lexically listed form of a word is equivalent to the form of the word as realized in isolation, then it follows that the neutralization depicted in tableau (3.43) is encoded as part of the lexically listed form. That is to say, the lexically listed form of a rhotic-final word may correspond to either (3.43b), with neutralized tap, or (3.43c), with neutralized trill, but not to (3.43a), in which the tap and trill are contrastive.

The effect of high-ranked LEX(duration) is that the neutralized quality of final rhotics will be generalized to all word-final positions at the phrasal level. This is formally illustrated in (3.44) for word-final prevocalic position:

\[(3.44)\quad \text{LEX(duration) ensures that the neutralized status of word-final tap and trill in the lexically listed form } L(W) \text{ is conserved prevocically in the phrasal form } T(W)\]

\[
\begin{align*}
L(W): & \quad \text{neutralization with variation (3.43b,c)} \\
T(W): & \quad \text{contrast} \\
& \quad \text{neutralization to tap} \\
& \quad \text{neutralization to trill} \\
\end{align*}
\]

What is important to notice with respect to the functioning of LEX(duration) in (3.44) is that this constraint prefers the same rhotic realizations in word-final prevocalic position as it does in phrase-final position. In tableau (3.43), the markedness constraints *HOLD
and *FAST collectively rule out the contrastive candidate (3.43a), yielding neutralization with variation between the tap and trill. As shown in (3.44), LEX(duration) achieves the same result at the phrasal level by ruling out the contrastive candidate Vr|V ≠ Vr|V.

Thus far, the analysis is only partially complete. Left to its own devices, high-ranked LEX(duration) potentially generalizes both neutralized tap and neutralized trill to word-final prevocalic positions. This is incorrect, however, since a word-final trill does not appear when the following word begins with a vowel (e.g., ma[r] azul vs. *ma[r] azul 'blue sea'). To complete the analytical picture, let us examine the role of the lower-ranked markedness constraints *HOLD and *FAST. Specifically, these two constraints, in conjunction with the effects of LEX(duration), prefer the tap over the trill in word-final prevocalic position, as illustrated in tableau (3.45):

(3.45) Lexical conservatism and lower-ranked articulatory markedness ensure neutralization to tap in word-final prevocalic position in Spanish

\[\text{L(W): } Vr \sim Vr \text{ } (=(3.43b,c))\]

<table>
<thead>
<tr>
<th></th>
<th>LEX(dur)</th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Vr</td>
<td>V ≠ Vr</td>
<td>V</td>
<td>*!</td>
<td>**</td>
</tr>
<tr>
<td>b.</td>
<td>Vr</td>
<td>V</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Vr</td>
<td>V</td>
<td></td>
<td>*</td>
<td>**!</td>
</tr>
</tbody>
</table>

LEX(dur) rules out the contrastive candidate (3.45a). Thus far in the evaluation, LEX(dur) has achieved the same results that *HOLD and *FAST do in the evaluation of phrase-final forms in (3.43b,c) above, namely neutralization with variation. Since the remaining
candidates (3.45b,c) tie on CONTRAST(dur/V_V), the decision is then passed to the lower-ranked markedness constraints.

Now, recall that *HOLD assigns one violation mark per trill in non-prevocalic positions, but that it evaluates prevocalic trills more stringently by assigning two marks. In Section 3.2.2.3, the assignment of multiple violations by *HOLD was motivated as a way to capture the greater impetus of trills to lenite to taps in prevocalic contexts. In tableau (3.45), the second violation of *HOLD serves to rule out candidate (c), and the remaining candidate (b) with word-final prevocalic tap emerges as optimal. In sum, the fact that *HOLD has stringency built-in with respect to the prevocalic trill permits a uniform account of the behavior of Spanish rhotics in two distinct environments, namely after heterorganic consonants and in word-final prevocalic position.50

50 As Eric Bakovic (personal communication) points out, one aspect of this analysis remains problematic. Recall that the sporadic appearance of trills in /Cr/ onsets was accounted for on the assumption that *FAST may fall into a categorical ranking relation with respect to *HOLD under conditions of highly emphatic speech (see tableau (3.34) and the surrounding discussion). However, if *FAST were to dominate *HOLD in tableau (3.45), then candidate (3.45c) would become optimal—clearly an undesirable result. Two responses to this criticism come to mind. First, it may be the case that claims in the empirical literature regarding the absence of word-final prevocalic trill are in fact based on data reflecting formal or careful speech styles (which correspond to the partial ranking of *HOLD and *FAST) as opposed to data representative of speech situations that are truly highly emphatic (which correspond to the ranking of *FAST » *HOLD). Second, the fact that the appearance of trills in /Cr/ onsets is so sporadic may also explain the lack of reports attesting to word-final prevocalic trills. Both phenomena result from a temporary demotion of *HOLD that occurs so infrequently as to be virtually impossible to detect in running speech. Clearly, further empirical research is required in order to investigate the possibility of word-final prevocalic trill under highly emphatic speech conditions as opposed to formal/careful styles.
3.3.3.2 Word-final Prevocalic Tap as The Emergence of The Unmarked

The obligatory neutralization of word-final rhotics to tap in prevocalic position may be viewed as a case of what McCarthy and Prince (1994) call *the emergence of the unmarked* (TETU). When a constraint C is crucially dominated by a higher-ranked constraint in some language, the effects of C are generally not visible. However, under those conditions where C is rendered irrelevant by some other dominant constraint, the effects of C become visible, and the output candidate unmarked with respect to C emerges as optimal. In Spanish, the ranking of CONTRAST(dur/V_V) » *HOLD generally ensures contrastive tap and trill between vowels. In word-final intervocalic position, high-ranked LEX(duration) nullifies the effects of intervocalic contrast by ruling out the contrastive candidate in (3.45a). Since CONTRAST(dur/V_V) is made irrelevant in this context, lower-ranked *HOLD favors neutralization to tap, which emerges as the unmarked rhotic between vowels in the optimal candidate (3.45b). The absence of word-final prevocalic trills is, therefore, a TETU effect.

In those dialects of European Portuguese that have alveolar trills, the ranking of *HOLD » *FAST, CONTRAST(dur) ensures phrase-final tap, thereby making word-final tap a property of lexically listed forms. High-ranking LEX(dur) generalizes the lexically listed form of tap-final words to all phrasal contexts, as shown in tableau (3.46):
Lexical conservatism ensures neutralization to tap in word-final prevocalic and word-final preconsonantal positions in European Portuguese

\[
L(W): Vr
\]

<table>
<thead>
<tr>
<th></th>
<th>LEX(dur)</th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (Vr</td>
<td>V \neq Vr</td>
<td>V)</td>
<td>*!</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>b. (Vr</td>
<td>V)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. (Vr</td>
<td>V)</td>
<td>*!</td>
<td>*</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>a. (Vr</td>
<td>C \neq Vr</td>
<td>C)</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b. (Vr</td>
<td>C)</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. (Vr</td>
<td>C)</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

In contrast to word-final prevocalic TETU effects in Spanish, LEX(dur) ensures neutralization to tap right off the bat in European Portuguese because lexically listed forms of rhotic-final words all contain final taps.51

In Catalan, there is a deletion process that affects word-final rhotics (Hualde 1992:406-7, Mascaró 1972:65-8, Morales 1995:43-45, Wheeler 1979:275-8). Although I will not attempt to provide an account of final deletion here, it is relevant to note that there are several lexical exceptions to final rhotic deletion (see Wheeler 1979:275-8 for a more complete discussion). In this small set of words that retain a final rhotic, we observe the same TETU effects in word-final prevocalic position as we do in Spanish. That is, despite variation in preconsonantal and phrase-final contexts, neutralization to tap is

---

51 The ranking of LEX(dur) » CONTRAST(dur/V\_V) in European Portuguese also makes the correct prediction that the trill should surface word-initially regardless of the final segment of the preceding word, exactly as in Spanish (see Mateus and Andrade 2000:11, 15).
obligatory when the following word begins with a vowel. The distribution of final rhotics in Catalan is shown in (3.47):

(3.47) Realizations of word-final rhotics immune to deletion in Catalan

a. \( ma[r \sim r||] \) 'sea'

b. \( ma[r \sim r]\) blau 'blue sea'

c. \( ma[r]\) antic 'ancient sea'
*\( ma[r]\) antic

This behavior is not surprising given the fact that *HOLD and *FAST are unranked with respect to one another in Catalan as they are in Spanish. The analysis of word-final TETU effects in Catalan is exactly the same as in Spanish, shown in tableau (3.45) above.

3.3.4 Lexical Conservatism Effects on Word-medial Rhotics in Dominican Spanish

Thus far in the analysis of Spanish rhotics, lexical conservatism has been shown to account for their asymmetrical behavior at the edges of words. High-ranking LEX(duration) cancels out the undesired effects of CONTRAST(duration) constraints on edge-adjacent rhotics at the phrasal level by generalizing properties of lexically listed forms. As a result, the phrase-initial trill is generalized as a word-initial property, while phrase-final variation gives way to word-final prevocalic tap as a TETU effect. Now, it is reasonable to ask whether lexical conservatism might have any visible effects in another intervocalic context, namely word-medially between vowels. In this section, I focus on
hypercorrection and preaspiration in Dominican Spanish and argue that lexical conservatism is at work in this position as well.

3.3.4.1 Blocking of Hypercorrective /s/-epenthesis

First, let us briefly review the facts of hypercorrection in Dominican Spanish, which were first discussed in Section 2.2.2 of Chapter 2. In this dialect, consonantal reduction in the syllable rhyme is so severe that syllable-final /s/ is arguably absent from the lexical representations of illiterate speakers (Terrell 1986). Núñez Cedeño (1988, 1994) documents a hypercorrection phenomenon in the speech of some Dominicans whereby /s/ is inserted in the syllable rhyme, yielding forms such as those in (3.48):


   asbogado  < abogado  'lawyer'
   abosgado
   abogasdo
   abogados

   bosfe  < bofe  'lung'
   bofes

One restriction on epenthesis stems from the lack of hypercorrect forms in which [s] appears immediately before intervocalic tap or trill, as shown in (3.49) and (3.50):
(3.49) Epenthetic [s] unattested before intervocalic tap
a. caros < caro 'expensive; dear'
b. *casro

(3.50) Epenthetic [s] unattested before intervocalic trill
a. carresta < carreta 'cart'
   carretas
b. *casrreta

While caros in (3.49a) and carresta/carretas in (3.50a) are possible hypercorrect forms for caro and carreta, respectively, *casro in (3.49b) and *casrreta in (3.50b) are totally unattested.

I argue that lexical conservatism is responsible for the blocking of hypercorrective /s/-insertion before intervocalic rhotics in Dominican Spanish. In the isolation form of a word, the tap and trill are in contrast word-medially between vowels, as guaranteed by the high ranking of CONTRAST(dur/V_V). I repeat tableau (3.19) below as a convenient reminder of the effects of this ranking:

(3.51) Maintenance of intervocalic contrast in word-medial position (repeated from tableau (3.19))

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>☒</td>
<td>a. VrV ≠ VrV</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. VrV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. VrV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I argue that lexical conservatism is responsible for the blocking of hypercorrective /s/-insertion before intervocalic rhotics in Dominican Spanish. In the isolation form of a word, the tap and trill are in contrast word-medially between vowels, as guaranteed by the high ranking of CONTRAST(dur/V_V). I repeat tableau (3.19) below as a convenient reminder of the effects of this ranking:
If the isolation form of a word counts as its lexically listed form, then rhotic duration contrast in word-medial intervocalic position, as shown in (3.51a), is also a property of lexically listed forms. The effect of high-ranked \textsc{Lex}(duration) is that the contrastiveness property of word-medial rhotics in the lexically listed form of a word will be conserved in the phrasal realizations of the word. This is illustrated in (3.52):

(3.52) \textsc{Lex}(duration) ensures that the contrastive status of word-medial intervocalic tap and trill in the lexically listed form \textsc{L}(W) is conserved word-medially in the phrasal form \textsc{T}(W)

\begin{align*}
\textsc{L}(W): & \quad VrV \neq VrV \\
\quad \text{contrast (3.51a)} \\
\textsc{L}(duration) & \quad \downarrow \\
\textsc{T}(W): & \quad \checkmark VrV \neq VrV \\
& \quad VrV \, \text{neutralization to tap} \\
& \quad \checkmark VrV \, \text{neutralization to trill}
\end{align*}

The blocking of epenthesis before intervocalic tap and trill results from the fact that insertion of /s/ would neutralize the contrast in this position, as ensured by \textsc{Fast/same site}. This is illustrated in tableau (3.53):
Lexical conservatism and \(*\text{FAST/SAME SITE}\) ensure failure of epenthesis before word-medial intervocalic rhotics

\[
\text{L(W): } \mathsf{VrV} \neq \mathsf{VrV} (=\text{(3.51a)})
\]

<table>
<thead>
<tr>
<th></th>
<th>LEX (dur)</th>
<th>CONTRAST (dur/\text{V}_\text{V})</th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>{s_r}_V \neq {sr}_V</td>
<td>*!</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>{s_r}_V</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>{sr}_V</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>\mathsf{VrV} \neq \mathsf{VrV}</td>
<td>*!</td>
<td>*!</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>e.</td>
<td>\mathsf{VrV}</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>f.</td>
<td>\mathsf{VrV}</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Candidates (3.53a–c) are otherwise identical to candidates (3.53d–f) except that epenthetic \([s]\) appears in the former set.\(^{52}\) \text{LEX(duration)} rules out the neutralization candidates (b,c) and (e,f) because they fail to maintain a lexical property, namely the contrast between tap and trill in word-medial intervocalic position of lexically listed forms.\(^{53}\) \*\text{FAST/SAME SITE}\ rules out candidate (a) because the tap is disallowed under

\(^{52}\) Hypercorrection presumably stems from the action of other constraints not shown in the tableau. However, instead of attempting a formal analysis here, I shall simply assume that candidates such as (3.53a–c) denote potential hypercorrected forms.

\(^{53}\) It is important to note here that while the rhotics in candidates (3.53a–c) are postconsonantal due to the presence of the preceding \([s]\), they are in fact \emph{intervocalic} in lexically listed forms. Recall the claim of Terrell (1986) that syllable-final /s/ is absent from the lexical representation of illiterate speakers. This means that in (3.52), [s] is absent from \text{L(W)}, which thus encodes the property of word-medial rhotic duration contrast. In tableau (3.53), \text{LEX(duration)} seeks to conserve the contrastiveness property, even though the rhotics are, strictly speaking, no longer intervocalic in \text{T(W)} due to hypercorrection. Contrast the functioning of \text{LEX(duration)} with that of the positional
Place/stricture-sharing configurations (see (3.20c)). Although (3.53c) satisfies *FAST/SAME SITE by ensuring a postconsonantal trill, it does so at the expense of neutralizing the tap/trill contrast, thus violating highest-ranked LEX(duration). Candidate (d)—without epenthesized [s]—is optimal since it is the only set of surface forms in which the tap and trill contrast without incurring a violation of *FAST/SAME SITE. The "blocking" of /s/-epenthesis, then, emerges as an effect of lexical conservatism, which strives to maintain the lexical property of word-medial intervocalic contrast.

### 3.3.4.1.1 Comparison with Correspondence Theory

A comparison of the present account with an input-output correspondence analysis lends support to the surface-oriented Dispersion Theory of contrast. In Flemming's (1995) Dispersion Theory, constraints demand phonological contrast directly in the output, thereby obviating the need for underlying representations (see Section 1.2.2.2 of Chapter 1). This is evident, for example, in tableau (3.51) above, in which candidates are idealized surface forms, and no reference to an underlying input form is required. On this analysis, CONTRAST(dur/V_V) simply favors those candidates in which the tap and trill are contrastive, such as VrV ≠ VrV in (3.51a), while the same constraint penalizes those candidates which exhibit neutralization, such as VrV and VrV in (3.51b) and (3.51c),

---

constraint CONTRAST(dur/V_V), which is irrelevant in candidates (3.53a–c) precisely because the rhotics are no longer intervocalic after epenthetic [s].
respectively. In (3.52) and the surrounding discussion, it was argued that lexically listed forms encode the property of word-medial rhotic duration contrast, and that \( \text{LEX}(\text{duration}) \) acts to conserve this property in phrasal realizations.

In Correspondence Theory, on the other hand, \( \text{IDENT–IO}(\text{F}) \) constraints do not evaluate the goodness of surface contrast. Rather, they merely check the faithfulness of output forms to input forms with respect to some feature value. Since surface contrasts are not evaluated directly in this approach, the blocking of hypercorrective /s/-epenthesis cannot be explained in terms of contrast maintenance. To see this, first consider the tableaux in (3.54) below. (N.B.: Surface-oriented \( \text{CONTRAST}(\text{duration}) \) constraints are replaced by input-output faithfulness \( \text{IDENT–IO}(\text{duration}) \) constraints, and hypothetical input forms are shown in the first cell of each tableau.)

(3.54) Input-output correspondence ensures faithfulness to underlying tap and trill in word-medial intervocalic position

<table>
<thead>
<tr>
<th>/\text{V}_r\text{V}/</th>
<th>\text{IDENT–IO} (\text{dur/V}_V)</th>
<th>\text{*HOLD}</th>
<th>\text{*FAST}</th>
<th>\text{IDENT–IO}(\text{dur})</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. \text{V}_r\text{V}</td>
<td>!</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. \text{V}_r\text{V}</td>
<td>*!</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>/\text{V}_r\text{V}/</th>
<th>\text{IDENT–IO} (\text{dur/V}_V)</th>
<th>\text{*HOLD}</th>
<th>\text{*FAST}</th>
<th>\text{IDENT–IO}(\text{dur})</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. \text{V}_r\text{V}</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d. \text{V}_r\text{V}</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Given an input tap, high-ranking IDENT–IO(dur/V_V) ensures its faithful realization between vowels in the optimal output candidate (3.54a). Similarly, IDENT–IO(dur/V_V) preserves an input trill between vowels in (3.54d).

Recall our assumption that the isolation form of a word counts as its lexically listed form. If the optimal forms in (3.54a) and (3.54d) are taken to represent isolation forms of words containing word-medial intervocalic rhotics, then they also count as the lexically listed forms of these words. The effect of high-ranked LEX(duration), then, will be to conserve the tap of (3.54a) and the trill of (3.54d) at the phrasal level, as illustrated in (3.55):

(3.55)  LEX(duration) ensures that a word-medial intervocalic rhotic in the lexically listed form L(W) is conserved word-medially in the phrasal form T(W)

\[
\begin{align*}
L(W): & \quad VrV \quad (3.54a) & \quad VrV \quad (3.54d) \\
T(W): & \quad \checkmark VrV & \ast VrV & \ast VrV & \checkmark VrV \\
& \quad \text{LEX(duration)} & \quad \text{LEX(duration)}
\end{align*}
\]

The functioning of LEX(duration) in an input-output correspondence-theoretic model, as shown in (3.55), is different from its functioning in the surface-oriented Dispersion-theoretic model shown in (3.52) above. On the input-output conception, it is the realization of individual rhotics that LEX(duration) seeks to generalize from L(W) to T(W). That is, lexical conservatism ensures faithfulness to the rhotic duration value present in L(W). In contrast, the Dispersion-theoretic conception of LEX(duration) allows
this constraint to generalize the property of surface contrast itself, or the lack thereof, precisely because contrast is enforced directly between surface forms in this theory.

Herein lies the shortcoming of an input-output correspondence analysis. Since the goodness of surface contrast is not evaluated, such an analysis is incapable of ruling out all output candidates in which epenthetic [s] appears before an intervocalic rhotic. This is demonstrated in tableaux (3.56) and (3.57) below:

(3.56) Input-output correspondence approach correctly predicts absence of hypercorrective [s] before word-medial intervocalic tap

L(W): VrV (= (3.54a))

<table>
<thead>
<tr>
<th>/VrV/</th>
<th>LEX (dur)</th>
<th>IDENT–IO (dur/V_V)</th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>IDENT–IO (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. V{s’r}V</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. V{sr}V</td>
<td>*!</td>
<td></td>
<td>**</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. VrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>d. VrV</td>
<td>*!</td>
<td>*</td>
<td>**</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Since L(W) contains an intervocalic tap, LEX(duration) in tableau (3.56) eliminates output candidates (b) and (c) because the surface trill is unfaithful. *FAST/SAME SITE rules out candidate (a), in which the tap appears in a Place/stricture-sharing configuration. This analysis correctly guarantees the absence of epenthetic [s] before a word-medial intervocalic tap. However, a problem arises with respect to intervocalic trill:
(3.57) Input-output correspondence approach incorrectly predicts possibility of hypercorrective [s] before word-medial intervocalic trill

L(W): VrV (=3.54d))

<table>
<thead>
<tr>
<th>/VrV/</th>
<th>LEX (dur)</th>
<th>IDENT–IO (dur/V_V)</th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>IDENT–IO (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. V{s′r}V</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. V{sr}V</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. VrV</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d. VrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>

Here, L(W) contains an intervocalic trill, and LEX(duration) rules out candidates (a) and (c) because the surface tap is unfaithful. LEX(duration) does not penalize candidates (b) and (d) because the surface trill is faithful to the trill present in L(W) in each case. Since (b) satisfies *FAST/SAME SITE by ensuring a trill under Place/stricture-sharing, and since no other constraints act to distinguish between (b) and (d), both of these candidates should be possible surface realizations. In other words, this analysis cannot rule out the possibility of epenthesis before a word-medial intervocalic trill, as shown by the ◆ symbol before candidate (b).

The failure of an input-output correspondence analysis to account for the Dominican Spanish facts is summarized by the diagrams in (3.58) and (3.59):
In (3.58), epenthesis before an intervocalic tap is successfully ruled out because the resulting surface trill is unfaithful to the lexically listed tap. In (3.59), epenthesis before an intervocalic trill does not yield the same breach of faithfulness because the lexically listed trill is maintained in the hypercorrected output form.

The surface-oriented Dispersion-theoretic model does not face the same problem. Since the contrast between the tap and trill is evaluated directly between surface forms, LEX(duration) is able to "see" the deleterious effect that epenthesis has with respect to rhotic contrastiveness in word-medial intervocalic position, as shown in (3.60):
The effect of epenthesis is that the lexically listed contrast in L(W) is neutralized at the surface in T(W). On the other hand, the absence of hypercorrective [s] allows the contrast to be conserved. The result emerging from this discussion is that an adequate account of the Dominican Spanish facts must be built upon a surface-oriented model of phonological contrast, which lends support to Flemming's (1995) Dispersion Theory approach.

### 3.3.4.1.2 An Alternative Analysis Based on Phonotactic Restrictions

Let us consider another possible analysis of the Dominican Spanish hypercorrection facts that incorporates a brute-force phonotactic constraint against /s/ + rhotic clusters. As Richard Page (personal communication) points out, such clusters appear to be rather marked cross-linguistically. For example, English contains many /sC/ clusters, but yet /s/ fails to cluster with a following rhotic. Additionally, /sr/ clusters are often lost historically through assimilation or epenthesis, as in Indo-European *sr > Germanic *str (e.g., *stream*).
Two pieces of evidence coming from Spanish dialects that retain syllable-final /s/ also hint at the markedness of /sr/ clusters. In both cases, however, counterarguments exist to suggest that a phonotactic constraint against such clusters is not responsible for the Dominican Spanish hypercorrection facts. First, /sr/ is often realized in many dialects as a coalesced retroflex fricative [z], e.g., *Israel* [izæel] 'Israel' (Harris 1969). Presumably, coalescence is a way to repair the phonotactically illicit cluster. If this is indeed the case, then one must wonder why coalescence is unattested in Dominican Spanish. That is, why do hypercorrecting Dominicans not insert /s/ before a rhotic and then repair the phonotactic violation by realizing the cluster as a retroflex fricative?\(^5^4\)

A second argument in favor of positing a phonotactic restriction is that the number of monomorphemic /sr/ clusters in the Spanish lexicon is admittedly scarce, with *Israel* 'Israel' and its derivatives *israeli* 'Israeli' and *israelita* 'Israelite' being virtually the only examples.\(^5^5\) It is plausible to think that the lack of /s/-epenthesis before rhotics stems from the fact that hypercorrecting Dominicans are rarely, if ever, exposed to such words in the speech of those whom they seek to imitate via /s/-epenthesis. Recall, however, that

\(^5^4\) Of course, this counterargument may be countered in turn by positing that the Dominican grammar contains a higher ranking markedness constraint banning retroflex fricatives such as [z]. However, it is not clear what motivation would exist for such an argument other than the need to explain why coalescence is an unattested repair for phonotactically illicit /st/ clusters.

\(^5^5\) Thanks to Eric Holt, John Lipski, and Ana Teresa Pérez-Leroux for independently reminding me of this fact.
hypercorrective epenthesis is essentially a sporadic phenomenon in which speakers attempt to redress the lack of syllable-final /s/ by reinserting it into some syllable-final position. That is to say, epenthesis is motivated by an awareness that some words pronounced by speakers of more conservative lects do exhibit syllable-final [s], but the process is hypercorrective in nature due to an uncertainty about which words should, in fact, contain syllable-final [s]. Given this general uncertainty, it is unclear why hypercorrecting Dominicans should happen to single out only words that contain intervocalic rhotics as being immune to /s/-epenthesis in the syllable rhyme.

To sum up, the fact that (1) coalescence of /str/ to [z] is a logically possible but nonetheless unattested repair and that (2) hypercorrection stems from a general uncertainty regarding the proper placement of syllable-final [s] both suggest that the explanation for the lack of epenthesis before intervocalic rhotics must involve something other than a phonotactic constraint against /s/ + rhotic clusters. In this section, I have developed such an explanation in terms of lexical conservatism: epenthesis is blocked in order to conserve a property of lexically listed forms, namely word-medial rhotic duration contrast.

3.3.4.2 Devoicing and Preaspiration

Further evidence in favor of lexical conservatism comes from other phenomena involving rhotics in Dominican Spanish. The tap and trill are reported to be voiceless in the speech
of many Dominicans (Jiménez Sabater 1975:86-87; Núñez Cedeño 1987). For many
Caribbean Spanish speakers, the durationally longer intervocalic rhotic seems to have two
phases of articulation: it begins with an aspirate moment followed by a voiceless alveolar
tap, as shown in (3.61). Intervocalic tap is devoiced but never preaspirated, as in (3.62).

(3.61) Devoicing and lenition of intervocalic trill to preaspirated tap (Núñez Cedeño
1994:31)

\[
\begin{align*}
\text{piza}[h_f]a & \quad < \text{pizarra} & \text{blackboard}' \\
\text{entie}[h_f]o & \quad < \text{entierro} & \text{burial'} \\
\text{bu}[h_f]o & \quad < \text{burro} & \text{donkey'} \\
\text{ba}[h_f]iga & \quad < \text{barriga} & \text{belly'} \\
\text{ba}[h_f]io & \quad < \text{barrio} & \text{neighborhood'}
\end{align*}
\]

(3.62) Devoicing (but no preaspiration) of intervocalic tap (Núñez Cedeño 1994:31)

\[
\begin{align*}
\text{pisa}[x]a & \quad *\text{pisa}[h_f]a & \text{he would step'} \\
\text{entie}[x]o & \quad *\text{entie}[h_f]o & \text{whole'} \\
\text{bu}[x]o & \quad *\text{bu}[h_f]o & \text{bureau'} \\
\text{va}[x]io & \quad *\text{va}[h_f]io & \text{several'}
\end{align*}
\]

According to Zlotchew (1974), the aspirate percept arises in intervocalic voiceless
trills because the glottal devoicing gesture comes to precede the lingual gesture
responsible for trilling, which is itself temporally reduced.

"The amount of time expended in producing the glottal fricative …
followed by the [tap] is roughly equivalent to the time element involved in
the realization of the multiple trill; however, the muscular effort has been
reduced in that the tongue need be kept in position for the shorter duration
of the simple vibrant [tap] only" (83).

In other words, devoicing of the trill combines with alternate oral-glottal gestural timing
in such a way as to allow preservation of rhotic duration contrast, despite temporal
reduction of the lingual trill gesture. The crucial point to understand here is that without
the concomitant devoicing gesture, reducing the duration of the trill would make this
rhotic perceptually equivalent to a tap, thereby neutralizing the contrast between the two.

Zlotchew's account of devoicing-cum-reduction provides an important basis upon
which to construct an analysis of the preaspiration data presented above. This analysis
requires two additional constraints. I assume that the constraint in (3.63) forces sonorants,
including rhotics, to be voiced:

\[(3.63) \quad \text{SONVOI (Itô, Mester, and Padgett 1995)}\]
\[\text{sonorant} \supset \text{voice}\]
\[(\text{Sonorants are voiced.})\]

The constraint in (3.64), adapted from Steriade (1997:70), encapsulates the timing
scenario responsible for preaspiration.\(^{56}\)

\[(3.64) \quad \text{T IMING}\]
\[\text{The peak of glottal abduction must lead or coincide with the onset of oral}\]
\[\text{constriction.}\]
\[\text{TIMING is satisfied by... but violated by...}\]
\[\text{h} \quad \text{C} \quad \text{h}\]
\[\text{[-----glottal abduction-----]} \quad \text{[-----glottal abduction-----]}\]
\[\text{[-----oral constriction-----]} \quad \text{[-----oral constriction-----]}\]

The TIMING constraint disfavors postaspirated consonantal articulations, in which glottal
devoicing extends beyond the offset of oral constriction.

For those speakers who pronounce rhotics as voiced, SONVOI outranks *HOLD, as
shown in tableau (3.65):

\[^{56}\text{In Steriade (1997), a constraint similar to TIMING in (3.64) is proposed for Tarascan, in which tense stops are realized with preaspiration postvocally.}\]
The ranking of $\text{SONVOI} \gg \ast\text{HOLD}$ ensures voicing of contrastive tap and trill $L(W): VrV \neq VrV \ (=(3.51a))$

<table>
<thead>
<tr>
<th></th>
<th>$\text{LEX}(\text{dur})$</th>
<th>$\text{CONTRAST} \ (\text{dur}/V_{-V})$</th>
<th>$\text{SONVOI}$</th>
<th>$\ast\text{HOLD}$</th>
<th>$\ast\text{FAST}$</th>
<th>$\text{TIMING}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>$VrV \neq VrV$</td>
<td></td>
<td></td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>$VrV$</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>$VrV_0 \neq VrV_0$</td>
<td></td>
<td></td>
<td><em>!</em></td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>d</td>
<td>$VrV_0$</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>$VrV_0 \neq VhrV_0$</td>
<td></td>
<td></td>
<td><em>!</em></td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>$VhrV_0$</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>$VhrV_0 \neq VhrV_0$</td>
<td></td>
<td></td>
<td><em>!</em></td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

Candidates (3.65a,b) contain voiced rhotics, while candidates (3.65c–g) contain voiceless ones. High-ranking $\text{LEX}(\text{dur})$ rules out the neutralization candidates (b), (d), and (f) because they fail to maintain rhotic duration contrast, which is a property of lexically listed forms. Of the remaining contrastive candidates, $\text{SONVOI}$ rules out (c), (e) and (g) because the rhotics are voiceless, leaving candidate (a) as optimal. What matters under the ranking of $\text{LEX}(\text{dur}) \gg \text{SONVOI} \gg \ast\text{HOLD}$ is that rhotics are voiced and in contrast intervocalically.

---

$\text{LEX}(\text{dur})$ refers only to the durational property of rhotics in $L(W)$ and not to their laryngeal status. Both the voiceless rhotics in (3.65d,f) and the voiced one in (3.65b) are penalized by $\text{LEX}(\text{dur})$ precisely because voicing is irrelevant to this constraint.

Strictly speaking, $\text{CONTRAST}(\text{dur}/V_{-V})$ achieves the same effects as $\text{LEX}(\text{dur})$ in tableau (3.65) as well as in tableau (3.66) below, which makes the latter constraint redundant. However, the need for $\text{LEX}(\text{dur})$, as well as its ranking above the $\text{CONTRAST}(\text{dur})$ hierarchy, is independently motivated by the behavior of rhotics in word-initial position (Section 3.3.2.2), word-final position (Section 3.3.3.1), and word-medial position with respect to Dominican Spanish hypercorrection (Section 3.3.4.1).
The opposite ranking *HOLD over SONVOI is appropriate for those speakers who pronounce voiceless rhotics. The combined effect of devoicing, oral-glottal timing, and lenition in generating preaspiration is illustrated by tableau (3.66):

(3.66) The ranking of *HOLD » SONVOI, TIMING yields preaspiration of intervocalic trill

L(W): VrV ≠ VrV (=(3.51a))

<table>
<thead>
<tr>
<th></th>
<th>LEX(dur)</th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>SONVOI</th>
<th>TIMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. VrV ≠ VrV</td>
<td></td>
<td></td>
<td>**</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. VrV</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. VrV ≠ VrV</td>
<td></td>
<td></td>
<td>**</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>*d. VrV</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>e. VrV ≠ VhV</td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. VhV</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>g. VhV</td>
<td></td>
<td></td>
<td>**</td>
<td>**</td>
<td></td>
<td>h!</td>
</tr>
</tbody>
</table>

As in tableau (3.65), high-ranking LEX(dur) rules out the neutralization candidates (b), (d), and (f) in (3.66) because they fail to maintain lexically-specified rhotic duration contrast. Of the remaining candidates, (a) and (c) fair the worst on lower-ranked markedness and are ruled out collectively by *HOLD and *FAST. Finally, candidate (g) violates TIMING, such that (e) emerges as optimal.

Observe that candidates (b) and (d) satisfy articulatory markedness by reducing the trill to a tap. However, this satisfaction comes only at the expense of neutralizing the duration contrast, as indicated by their fatal violations of LEX(dur). Now, if glottal abduction leads oral constriction, then the trill may reduce to a tap without loss of rhotic
duration contrast, as in candidate (e). In sum, candidate (e) is optimal because it is the
only set of surface forms in which temporal reduction can affect the trill without
neutralizing the tap/trill contrast. Similarly, candidate (f) shows why speakers never
preaspirate intervocalic tap: to do so would result in neutralization.

3.3.5 Neutralization of Postlexical Rhotic Clusters

In Iberian Romance languages, a word-final tap is deleted when it precedes a word-initial
alveolar trill. Harris (1983:63) cites the examples in (3.67) to show that postlexical
sequences of tap + trill are neutralized to trill in Spanish:

(3.67) Postlexical rhotic sequences in Spanish (Harris 1983:63)

a. salí rápido      [sali rapiðo]      'I left rapidly'
salir rápido      [sali rapiðo]      'to leave rapidly'

b. gamba rara      [gamba rara]      'strange shrimp'
ambar raro      [amba raro]      'strange amber'

Mateus and Andrade (2000:145) show that the deletion of a word-final rhotic in
European Portuguese depends on what kind of word-initial rhotic speakers use. The data
in (3.68) demonstrate that a word-final tap is deleted only when the following word-
initial trill is homorganic (i.e., alveolar):
(3.68)  Postlexical rhotic sequences in European Portuguese (Mateus and Andrade 2000:145)

a. Tap deleted before alveolar trill
   \[ \text{por regra} \quad [\text{pu} \text{ r} \text{ê} \text{r}] \quad \text{'by rule'} \]

b. Tap retained before uvular trill
   \[ \text{por regra} \quad [\text{pu} \text{ r} \text{ê} \text{r}] \quad \text{'by rule'} \]

3.3.5.1 Rhotic Cluster Neutralization and Phonotactic Constraints

The neutralization of postlexical rhotic sequences in Iberian Romance appears to be part of a broader phonotactic restriction on the clustering of these segments cross-linguistically. Walsh (1997:92) observes that "[r]hotic clusters are exceedingly rare and almost universally prohibited," citing two Australian languages as the only attested examples. She proposes a constraint against clusters of two coronal rhotics, which I adapt in (3.69):

(3.69)  Rhotic clustering constraint (adapted from Walsh 1997:93)

\[ *[\text{rho}] [\text{rho}] \]
\[ | \quad | \]
\[ \text{cor} \quad \text{cor} \]

According to this constraint, two root-adjacent segments may not be specified for [rhotic] if they are both coronal. As it is currently formulated, however, this constraint in itself does not explain why deletion affects the first rhotic and not the second one in (3.67) and (3.68a). To see this, let us also assume the constraint \( \text{LEX(segment)} \) in (3.70), which

\[ \text{LEX(segment)} \]

59 Walsh (1997:93) notes that an alternative formulation of this constraint might depict both rhotics as being linked to a single coronal Place node.
reflects a lexical conservatism condition enforcing the preservation of lexically specified segments:

(3.70) \textsc{lex(segment)}

Given \(T(W)\), the form of a word \(W\) appearing under evaluation, and \(L(W)\), the lexically listed form of \(W\), every segment of \(L(W)\) is conserved in \(T(W)\).

This constraint essentially forbids the deletion of segments that are present in the listed form of a given word (cf. the MAX–IO family of constraints in McCarthy and Prince 1995). The fact that neutralization of postlexical clusters involves deletion suggests that \textsc{lex(segment)} is dominated by the cluster constraint in (3.69). However, this in itself does not achieve the desired results, as tableau (3.71) demonstrates:

(3.71) **Rhotic clustering constraint unable to rule out deletion of word-initial trill**

<table>
<thead>
<tr>
<th></th>
<th>*[rho]</th>
<th>*[rho]</th>
<th>\textsc{lex(segment)}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>cor</td>
<td>cor</td>
<td></td>
</tr>
<tr>
<td>a. VrV</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. VrV</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. VrV</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

While the clustering constraint penalizes the intervocalic tap + trill sequence in (3.71a), \textsc{lex(segment)} fails to rule out either remaining candidate. This analysis predicts that when a word-final tap abuts a word-initial trill at the phrasal level, the cluster should neutralize with variable realization between a single tap or trill—contrary to the empirical facts in (3.67) and (3.68a). The problem is that either of the two rhotics may be deleted in order to satisfy the clustering constraint.
3.3.5.2 Rhotic Cluster Neutralization and Targeted Constraints

Here I develop an analysis which reformulates the phonotactic restriction in (3.69) as a *targeted* markedness constraint in the sense originally proposed by Wilson (1999). Targeted constraints have a substantive basis in perceptual similarity, as illustrated by the principle in (3.72):

\[
\text{(3.72) Weak Element Principle (Wilson 1999:16)}
\]

A representation \( x \) that contains a poorly-cued (or 'weak') element \( \varsigma \) is marked relative to the representation \( y \) that is identical to \( x \) except that \( \varsigma \) has been removed.

Wilson (1999) explains the intuition behind this principle as follows: "given two surface representations that sound basically the same (and which could therefore be easily confused by the hearer), the more complex representation is marked relative to the less complex representation" (16). Targeted constraints mark candidates containing perceptually weak elements that are not easily distinguishable from otherwise identical candidates lacking those weak elements.

Before recasting the constraint in (3.69) as a targeted markedness constraint, let us examine the aperture-theoretic representations in (3.73) to understand why a word-final tap is perceptually weak before an alveolar trill:

\[
\text{(3.73) Word-final tap before alveolar versus uvular trill}
\]

\[
\begin{align*}
a. & \quad V [\rho] [\rho] V \\
& \quad \text{cor} \quad \text{cor} \\
& \quad A_v \ A_t \ A_m \ A_t \ A_v

d. & \quad V [\rho] [\rho] V \\
& \quad \text{cor} \quad \text{dor} \\
& \quad A_v \ A_t \ A_m \ A_t \ A_v
\end{align*}
\]
The articulatory representation in (3.73a) presumably yields an acoustic representation in which the single constriction period of the word-final alveolar tap is directly adjacent to the multiple (i.e., two or more) constrictions of the following word-initial alveolar trill. Since the duration of the trill is sustainable, it is plausible that speakers would interpret the entire sequence of multiple contacts resulting from (3.73a) as perceptually equivalent to a single trill. That is to say, a sequence of tap + alveolar trill is not easily distinguishable from a single alveolar trill.

The hypothetical Figures 3–15 and 3–16 below illustrate the perceptual equivalence of a tap + alveolar trill sequence and a single prolonged trill. In Figure 3–15, the \( A_vA_tA_m \) sequence of the postvocalic tap abuts the single \( A_t \) position of the prevocalic trill, which in this case consists of two alveolar contact periods. The schematic trajectory of the tongue tip resulting from the combined aperture sequence yields an overall acoustic representation consisting of three interruptions of surrounding vocalic aperture. In contrast, Figure 3–16 depicts a single intervocalic trill whose duration is prolonged such that the passive vibration of the tongue tip produces three alveolar contacts, unlike the two-contact trill of Figure 3–15. A comparison of both configurations reveals that the acoustic results are essentially equivalent. That is to say, a tap + two-contact alveolar trill sequence and a single three-contact alveolar trill both produce a total of three stop-like moments alternating with greater periods of sonority. Therefore, the claim that a tap is perceptually weak before an alveolar trill is motivated by the fact that the acoustic representation in Figure 3–15 is not easily distinguishable from that shown in Figure 3–16.
Given the perceptual weakness of the tap before an alveolar trill, the Weak Element Principle motivates the formulation of the targeted constraint shown in (3.74), with which I replace the constraint in (3.69) above:
Let \( x \) be any candidate and \( \varsigma \) be any rhotic in \( x \) that is perceptually weak. If candidate \( y \) is exactly like \( x \) except that \( \varsigma \) has been removed, then \( y \) is more harmonic than \( x \).

In order to see how the ranking of \textsc{NoWeakRhotic} \( \gg \text{LEX(segment)} \) ensures deletion of the word-final but not of the word-initial rhotic in (3.73a), it is necessary to consider how optimal candidates are arrived at under an order-based approach to optimization. When a pair of candidates is evaluated by some constraint, that constraint selects one member of the pair as being more harmonic than the other member. That is, the constraint asserts an \textit{harmonic ordering} between the two candidates, such as \( x \gg y \), which denotes that candidate \( x \) is more harmonic than candidate \( y \). As constraint evaluation proceeds down the hierarchy, a \textit{cumulative ordering} among candidates is progressively established. Crucially, the harmonic ordering asserted by some higher-ranked constraint is never changed by a lower-ranked one. After all constraints have had their turn in the evaluation, the most harmonic candidate in the cumulative ordering emerges as optimal. A more formal definition of order-based optimization is given in (3.75):
Order-based optimization (adapted from Wilson 1999:22)

a. Ordering
   Starting with the highest-ranked constraint in the hierarchy, if the current constraint asserts the ordering \( x \succ y \), then add \( x \succ y \) to the cumulative ordering \( O \), except when the opposite ordering (i.e., \( y \succ x \)) is in \( O \). Repeat for the next highest-ranked constraint in the hierarchy.

b. Transitive Closure
   For any candidates \( x, y, \) and \( z \), if both \( x \succ y \) and \( y \succ z \) are in the cumulative ordering \( O \), then \( x \succ z \) is also in \( O \) (i.e., \( x \succ y \) & \( y \succ z \Rightarrow x \succ z \)).

c. Optimality
   A candidate is optimal iff it is not worse than any other candidate in the final cumulative ordering (i.e., when the loop in (a) ends).

The tableau in (3.76) shows how the targeted constraint \( \text{NOWEAKRHOTIC} \) guarantees the deletion of word-final taps. (N.B.: The arrow symbol \( \Rightarrow \) denotes a targeted constraint. The 'cumulative ordering' row at the bottom of the tableau helps to keep track of the entire set of harmonic orderings established by the constraint hierarchy thus far. The comparison symbol \( \succ \) signifies 'is more harmonic than'.)

(3.76) Targeted contextual markedness ensures deletion of word-final tap before alveolar trill

<table>
<thead>
<tr>
<th></th>
<th>( \Rightarrow \text{NOWEAKRHOTIC} )</th>
<th>\text{LEX}(segment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>VlrV</td>
<td>VlrV \succ VlrV !</td>
</tr>
<tr>
<td>b</td>
<td>VlrV</td>
<td>(VlrV \succ VlrV)</td>
</tr>
<tr>
<td>c</td>
<td>VlrV</td>
<td>VlrV \succ VlrV !</td>
</tr>
<tr>
<td>Cumulative ordering:</td>
<td>VlrV \succ VlrV</td>
<td>VlrV \succ VlrV \succ VlrV</td>
</tr>
</tbody>
</table>
Candidate (a) violates NOWEAKRHOTIC because the word-final tap appears in a
perceptually weak position, i.e., before an alveolar trill. Since this constraint is targeted, it
asserts that candidate (b) is more harmonic than (a), i.e., VlrV \succ VrlrV, because the two
are otherwise identical except that the perceptually weak word-final tap is absent from
the former. This harmonic ordering is added to the cumulative ordering in the bottom row.

Next, the anti-deletion constraint LEX(segment) is violated by candidates (b) and
(c) because in each case, a segment present in the listed form of a word does not have a
correspondent in the form under evaluation. LEX(segment) asserts that the non-deleting
candidate (a) is more harmonic than candidate (b), in which a lexical segment has been
deleted, i.e., VrlrV \succ VlrV. Observe that this ordering is the exact opposite of the one
asserted by higher-ranked NOWEAKRHOTIC, VlrV \succ VrlrV. According to the order-based
optimization procedure in (3.75a), an ordering is added to the cumulative ordering except
when the opposite ordering is already there by virtue of some higher-ranked constraint.
Since VlrV was already deemed more harmonic than VrlrV by NOWEAKRHOTIC,
LEX(segment) cannot change the relative harmony of the two candidates. In the third row
of tableau (3.76), parentheses are used to indicate that the harmonic ordering VrlrV \succ
VlrV is not added to the cumulative ordering.

With respect to candidate (c), LEX(segment) again asserts the greater harmony of
the non-deleting candidate (a), i.e., VrlrV \succ VrlV. When this ordering is added to
cumulative ordering, we see the effects of transitive closure, defined in (3.75b). Thus far
in the evaluation, NOWEAKRHOTIC has already placed candidate (b) over (a) in the cumulative ordering. When LEX(segment) places candidate (a) over (c), then (b) is also more harmonic than (c) by transitivity. Thus we arrive at the final cumulative ordering \( V'l'rV > V'rV > V'lV \). Since candidate (b) is the most harmonic of the three candidates, it emerges as optimal according to (3.75c).

A comparison with the non-targeted approach to the neutralization of postlexical rhotic clusters demonstrates why the constraint in (3.69) fails. The following tableau repeats the evaluation carried out in (3.71) above, but with harmonic orderings indicated instead of constraint violations:

(3.77) Why the non-targeted anti-cluster constraint fails

<table>
<thead>
<tr>
<th></th>
<th>*[rho] [rho]</th>
<th>LEX(segment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>cor</td>
<td>cor</td>
<td></td>
</tr>
<tr>
<td>a. V'l'rV</td>
<td>V'l'rV &gt; V'rV !</td>
<td>V'lV &gt; V'rV !</td>
</tr>
<tr>
<td>b. V'lV</td>
<td>(V'l'rV &gt; V'lV)</td>
<td></td>
</tr>
<tr>
<td>c. V'rV</td>
<td>(V'l'rV &gt; V'rV)</td>
<td></td>
</tr>
</tbody>
</table>

Cumulative ordering: \( V'l'rV > V'rV \) \( V'lV > V'rV \)

Only candidate (a) violates the cluster constraint. Unlike NOWEAKRHOTIC, however, the cluster constraint asserts that both (b) and (c) are more harmonic than the non-deleting candidate (a). Since it is not grounded in the Weak Element Principle, this constraint cannot ensure that deletion of the perceptually weak word-final tap will be the only possible repair to the phonotactic violation. The harmonic ordering of both deletion
candidates (b) and (c) over the non-deleting (a) enters the cumulative ordering, and evaluation continues with the next constraint. \text{LEX(segment)} asserts exactly the opposite harmonic orderings, which cannot be added to the cumulative ordering, as indicated by shading in the final cell. In the end, the final cumulative orderings of $V\text{r} lV \succ V\text{r} lV$ and $V\text{r} lV \succ V\text{r} lV$ collectively predict that either rhotic may be deleted in order avoid the cluster violation.

The final piece of data to account for is the fact that in some European Portuguese dialects, word-final taps fail to delete when the following word-initial trill is uvular, i.e., heterorganic. It was argued above that the multiple contacts resulting from the alveolar tap + trill sequence in (3.73a) are not easily distinguishable from those of a single alveolar trill. On the other hand, the multiple contacts resulting from the alveolar tap + uvular trill sequence in (3.73b) are plausibly distinguishable because the two rhotics possess different cues to place of articulation. Since a word-final tap is not in a perceptually weak position before uvular trills, \text{NOWEAKRHOTIC} does not come into play in the evaluation. This is demonstrated in tableau (3.78):

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
\textbf{Cumulative ordering:} & $V\text{r} lV \succ V\text{r} lV$ \\
\hline
\end{tabular}
\end{table}

\textit{(3.78)} Targeted contextual markedness is irrelevant in the case of word-final tap before heterorganic trill
Since candidate (a) does not violate the targeted constraint, no harmonic orderings can be established thus far. LEX(segment) is violated by the deleting candidates (b) and (c) and thereby asserts the harmonic ordering of both below the non-deleting candidate (a), i.e., \( Vr|RV > V|RV \) and \( Vr|RV > Vr|V \). Since the most harmonic candidate is (a), the alveolar tap is predicted to cluster with a following uvular trill—exactly the attested behavior in those varieties of European Portuguese in which trills are realized as uvular.

In conclusion, I have proposed a targeted constraints approach to the neutralization of postlexical rhotic sequences which correctly predicts the deletion of word-final taps before word-initial alveolar trills in Iberian Romance. As we will see in Section 5.3.2 of Chapter 5, the targeted constraint NOWEAKRHOTIC also plays a role in the neutralization of morphologically derived tap + tap sequences.

3.4 Comparison with Syllable-based Accounts

In this chapter, I have argued that the constraint rankings in (3.79) are responsible for the rhotic patterns of Iberian Romance varieties with alveolar trills:
(3.79) Constraint rankings for Iberian Romance varieties with alveolar trills

<table>
<thead>
<tr>
<th>a. Spanish and Catalan</th>
<th>b. European Portuguese</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEX(dur)</td>
<td>LEX(dur)</td>
</tr>
<tr>
<td>CONTRAST(dur/V_V),</td>
<td>CONTRAST(dur/V_V),</td>
</tr>
<tr>
<td>*FAST/INITIAL</td>
<td>*FAST/INITIAL</td>
</tr>
<tr>
<td>CONTRAST(dur#_V),</td>
<td>CONTRAST(dur#_V),</td>
</tr>
<tr>
<td>*FAST/SAME</td>
<td>*FAST/SAME</td>
</tr>
<tr>
<td>*HOLD,</td>
<td>*HOLD</td>
</tr>
<tr>
<td>*FAST</td>
<td>*FAST,</td>
</tr>
<tr>
<td>CONTRAST(dur)</td>
<td>CONTRAST(dur)</td>
</tr>
</tbody>
</table>

In the remainder of this chapter, explicit comparisons are made with existing prosodic accounts. I show how the analysis developed here successfully accounts for several facts that remain problematic under previous proposals.

### 3.4.1 Neutralization of Postlexical Rhotic Sequences

As discussed in Chapter 2, Harris (1983) posits the rule in (3.80) to account for the deletion of word-final taps before trills in Spanish:

(3.80) Deletion ensures that [rr] is not distinct from [r] (Harris 1983:63)

\[ r \rightarrow \emptyset / \_ r \]

Deletion of word-final taps is accounted for by the postlexical application of this rule. Subsequent analyses, such as Lipski (1990), Morales-Front (1994) and Bakovic (1994), do not consider the realization of postlexical rhotic sequences and, therefore, make no provision for a rule or constraint that would ensure neutralization to trill. Although the
analysis of Núñez Cedeño (1988, 1994) might account for postlexical clusters by assuming Harris' (1983) tap deletion rule, a separate and somewhat redundant rule would still be necessary in order to convert the dually-linked geminate structure to a phonetic trill in word-medial position, which only complicates the grammar. Bonet and Mascaró (1997) essentially agree with Harris and assume the rule shown in (3.80). Since they assume the trill to be a single underlying unit, no separate rule is required which converts a dually-linked geminate to a trill in word-medial intervocalic position.

There are two main problems with the rule in (3.80). First, why should it target the first rhotic of a cluster for deletion as opposed to the second? While the rule captures the descriptive fact, it fails to explain why the trill is never deleted instead of the tap. Second, it is unclear why those European Portuguese dialects with uvular trills do not have a deletion process paralleling that in (3.80). That is, why should Place make a difference in the neutralization of rhotic clusters? Again, the rule in (3.80) is an adequate description of the facts, but it offers little insight as to why we do not find a rule such as that in (3.81) in European Portuguese:

(3.81) Hypothetically possible but unattested deletion rule for European Portuguese

\[ r \rightarrow \emptyset / \_ _ r \]

In Section 3.3.5, it was argued that driving force behind the neutralization of postlexical rhotic sequences is a broadly attested restriction on the clustering of coronal rhotics. This restriction was formulated as a targeted markedness constraint, \textsc{NoWeakRhotic}, which ultimately guarantees deletion of the perceptually weak word-final tap before a word-initial alveolar trill. The failure of deletion to occur before uvular
trills stems from the fact this is not a perceptually weak position for the alveolar tap, as ensured by discernible differences in the place cues of the two rhotics. The targeted constraints analysis surpasses the rule-based deletion account by exposing the perceptual basis underlying rhotic cluster neutralization. In short, taps delete because they are perceptually indistinguishable before homorganic trills.

3.4.2 Rule Ordering and Word-final Prevocalic Tap

In Spanish and Catalan, neutralization to tap is obligatory word-finally before vowels, while the tap and trill are in non-contrastive, stylistically-controlled variation before both consonants and pause. Previous accounts have attempted to explain the lack of trills in word-final prevocalic contexts by ordering a resyllabification rule before an optional coda strengthening rule at the postlexical level. When a word-final tap is resyllabified to the onset of the following word, coda strengthening can no longer apply to it. The rule-bleeding account originates with Harris (1983), and subsequent analyses either assume this account or remain silent on the issue of obligatory neutralization to tap in this environment.60 Sample derivations from Spanish are given in (3.82) below:

60 In Chapter 2, I considered possible modifications of the OT analyses of Bakovic (1994) and Morales-Front (1994) in order to account for cases of optional emphatic strengthening in clusters and in word-final position. However, the accounts remain problematic since they lack a mechanism to ensure taps in word-final prevocalic position (see Sections 2.2.4 and 2.2.5).
(3.82) Rule-bleeding account of obligatory neutralization to tap in word-final prevocalic contexts in Spanish

<table>
<thead>
<tr>
<th>UR:</th>
<th>/mar beɾде/</th>
<th>/mar/</th>
<th>/mar a.sul/</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lexical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syllabification</td>
<td>mar</td>
<td>ber.de</td>
<td>mar</td>
</tr>
<tr>
<td><strong>Postlexical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resyllabification</td>
<td>—</td>
<td>—</td>
<td>ma.r</td>
</tr>
<tr>
<td>Coda strengthening</td>
<td>mar</td>
<td>ber.de</td>
<td>mar</td>
</tr>
<tr>
<td><strong>SR:</strong></td>
<td>[mar</td>
<td>βer.de]</td>
<td>[mar]</td>
</tr>
<tr>
<td>'green sea'</td>
<td>'sea'</td>
<td>'blue sea'</td>
<td></td>
</tr>
</tbody>
</table>

According to Harris (1983), the ordering of resyllabification before coda strengthening at the postlexical level "is predictable on the not implausible assumption that prosodic rules precede segmental rules of the same (lexical or postlexical) type, at least in the unmarked case" (77). However, there is no apparent reason to rule out the possibility of the coda strengthening rule applying after syllabification at the lexical level, which would not contravene Harris' assumption about the ordering of prosodic rules with respect to segmental ones at the same level. The lexical application of this rule would potentially—and undesirably—generate word-final prevocalic trills, as shown in (3.83):
Coda strengthening before resyllabification

<table>
<thead>
<tr>
<th></th>
<th>/mar berde/</th>
<th>/mar/</th>
<th>/mar asul/</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lexical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syllabification</td>
<td>mar</td>
<td>ber.de</td>
<td>mar</td>
</tr>
<tr>
<td>Coda strengthening</td>
<td>mar</td>
<td>ber.de</td>
<td>mar</td>
</tr>
<tr>
<td><strong>Postlexical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resyllabification</td>
<td>—</td>
<td>—</td>
<td>ma</td>
</tr>
</tbody>
</table>

SR:  [mar|ber|de]   [mar]   *[ma.r|a.sul]   'green sea'   'sea'   'blue sea'

Under this scenario, coda strengthening is no longer bled by postlexical resyllabification, and underlying /mar asul/ surfaces incorrectly as *[ma.r|a.sul] 'blue sea', with the trill in word-final prevocalic position. One must wonder why this type of derivation is universally unattested among varieties of Iberian Romance.\(^{61}\) Harris' rule-bleeding account adequately describes the facts, but only at the price of stipulating the application of coda strengthening at the postlexical level.

In contrast, the analysis developed here captures neutralization to tap in word-final prevocalic contexts as an effect of LEX(dur), whose ranking over CONTRAST(dur/V_V) is independently motivated by the behavior of rhotics at the other end of the word. In Section 3.3.2.1, the ranking of LEX(dur) » CONTRAST(dur/V_V) was

---

\(^{61}\) See Pensado (1984) for apparent counterexamples, which, however, involve spelling pronunciations of foreign words ending in orthographic –rr. Another partial exception is the assibilated pronunciation [z] of highland Ecuadorian Spanish, which occurs phrase-finally and can carry over to word-final prevocalic position, e.g., ir ahora [iz|aora] 'to go now' (Lipski 1990:156, Fn. 4). See Bradley (1999) for a derivational account of the Ecuadorian Spanish pattern that builds upon the analysis of Lipski (1989).
established on the basis of obligatory word-initial trill. *FAST/INITIAL ensures initial strengthening in the lexically listed isolation form, and LEX(dur) makes this an invariant word-initial property, even when the phrasal syntactic context might have otherwise licensed a rhotic duration contrast. In Section 3.3.3.1, LEX(dur) was also shown to nullify the effects of CONTRAST(dur/V_V) in word-final prevocalic position, thereby allowing lower-ranked markedness constraints to determine the outcome. I repeat tableau (3.45) for convenience below:

\[(3.84) \text{ Neutralization to tap in word-final prevocalic contexts as TETU (}= (3.45) \]

\[
\text{L(W): } V_r \sim V_r = (3.43b,c))
\]

<table>
<thead>
<tr>
<th></th>
<th>LEX(dur)</th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (V_r</td>
<td>V \neq V_r</td>
<td>V)</td>
<td>*!</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>b. (V_r</td>
<td>V)</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. (V_r</td>
<td>V)</td>
<td>*</td>
<td>**!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

LEX(dur) rules out the contrastive candidate (a), and *HOLD can now decide in favor of candidate (b). On this analysis, the tap simply emerges as the unmarked rhotic in word-final prevocalic position when lower-ranked markedness constraints are given the chance to exert their effects.

In sum, the TETU analysis successfully explains the intricacies of word-final neutralization without syllable structure and ordered rules—a welcome result, given our assumptions regarding Segmental Autonomy and the non-derivational nature of constraint-based OT (see the discussion of theoretical assumptions in Section 1.2 of Chapter 1). Furthermore, the absence of word-final prevocalic trills is intimately linked to
the obligatory presence of word-initial trills under this analysis, since each necessitates the ranking of \textsc{lexdur} \textgreater \textsc{contrast(dur/V\_V)}. The behavior of rhotics in two distinct environments falls out from one and the same constraint ranking. This constitutes a very interesting and novel result, insofar as no previous analysis of Spanish rhotics has ever attempted to draw a connection between these two phenomena.

### 3.4.3 Structure Preservation and Hypercorrection

To account for the fact that hypercorrection in Dominican Spanish involves insertion of /s/ at the end of a syllable, Núñez Cedeño (1988) posits the rule in (3.85):

(3.85) /s/-epenthesis rule (Núñez Cedeño 1988:324)

\[
\emptyset \rightarrow s / \_\_ ]\sigma
\]

Since this rule is structure-preserving, it fails to apply if general syllabic or prosodic constraints would be violated. Specifically, application of the rule in (3.85) is blocked if the result would either create structures not otherwise generated by phonological rules or alter the phonological features of immediately adjacent segments.

Specifically, /s/-epenthes before an intervocalic trill would violate the universal constraint on crossing association lines. The application of (3.85) in the first syllable of a word like \textit{carreta} 'cart' would yield the structure in (3.86), in which coda [s] illegally splits the heterosyllabic geminate tap:
Epenthesis before trill generates an ill-formed prosodic structure in which association lines are crossed (Núñez Cedeño 1994:31)

\[
\begin{array}{ccccccc}
\sigma & \sigma & \sigma & \sigma \\
C & V & C & C & V & C & V \\
\end{array}
\] \rightarrow
\begin{array}{ccccccc}
\sigma & \sigma & \sigma & \sigma \\
C & V & C & C & V & C & V \\
\end{array}

Structure preservation also explains epenthesis blocking before intervocalic taps, since the result would alter the phonological features of the adjacent rhotic. The application of (3.85) in the first syllable of caro 'expensive; dear' would trigger fortition of /r/ to trill, by the independent rule shown in (3.87):

(3.87) Postconsonantal strengthening rule (Harris 1983)

\[
\begin{array}{c}
r \rightarrow r / [+cons] \_ \\
| \\
\text{Rhyme} \\
\end{array}
\]

On the assumption that epenthesis is a structure-preserving rule, the ill-formed prosodic structure in (3.86) and the gratuitous modification of the underlying tap induced by the application of (3.87) both serve to block /s/-epenthesis before rhotics in intervocalic position. The lack of epenthesis in this environment suggests that the heterosyllabic geminate cluster proposed by Harris (1983) should be represented as a one-to-many association of a single underlying /r/ to two timing slots, as shown in (3.86).

In fact, Núñez Cedeño (1994) argues that /s/-epenthesis should be possible before an intervocalic trill in an analysis positing a unitary underlying trill /r/. While other recent accounts of Spanish rhotics have posited that the trill is a single unit, they have failed to
show how the Dominican facts might be explained without the assumption that the surface trill is an underlying geminate.

The analysis developed in this chapter is among those positing that the trill is a single unit, as shown by the monosegmental aperture-theoretic representation in (3.6b). However, this assumption does not preclude an account of epenthesis blocking—contrary to Núñez Cedeño's prediction. In Section 3.3.4.1, the lack of epenthetic [s] was shown to emerge as a consequence of independently motivated lexical conservatism conditions. Not only does the ranking of $\text{LEX(dur)} \gg \text{CONTRAST(dur/V_V)}$ explain the behavior of rhotics in word-initial and word-final intervocalic contexts at the phrasal level, it also explains why /s/ is never inserted before a word-medial intervocalic tap or trill: to do so would neutralize contrast, which is a property of lexically listed forms that contain rhotics in that position. The lexical conservatism analysis surpasses the structure-preservation account in that the latter requires two constraints, namely that (1) association lines must not be crossed and (2) adjacent segments must not be altered, while the former appeals to a single constraint, namely $\text{LEX(duration)}$. In Section 3.3.4.2, further evidence was presented from Dominican Spanish in support of lexical conservatism: devoicing and preaspiration must accompany the temporal reduction of the intervocalic trill in order to avoid neutralization.

No previous proposal in the literature has attempted to explain the behavior of intervocalic taps and trills in word-initial, word-medial, and word-final contexts using a single formal mechanism. In the present analysis, lexical conservatism achieves this by ensuring the preservation of a lexically listed property in all three contexts: neutralization
of rhotic duration contrast at the edges of words, but preservation of the contrast word-medially. Furthermore, lexical conservatism accounts for the blocking of /s/-epenthesis without the need for a geminate representation of the trill. This is a welcome result given the fact that in some languages, the trill cannot be analyzed as a geminate. By positing that the trill is a single phonological unit, the present analysis can be readily extended to cover all languages of the rhotic duration typology, which is the goal of the following chapter.

62 See Section 2.3.1 of Chapter 2 on the behavior of trill as a single phonological unit.
Chapter 4

Typological Predictions Beyond Iberian Romance

Among those languages exhibiting a phonological contrast between the coronal tap and trill, the Iberian Romance family has arguably received the most descriptive and theoretical attention since the advent of generative phonology. However, Catalan, European Portuguese, and Spanish constitute only a subset of languages relevant to the construction of an adequate theory of the typological behavior of these rhotics.

This chapter has two main goals, one empirical and one theoretical. First, it will be shown that those Iberian Romance varieties with alveolar trills constitute one of three major typological patterns with respect to contrast preservation. The survey of other languages carried out in this chapter yields a complete typology comprising ten languages, as shown in *Table 4–1*: 
Table 4–1: Typological survey of languages with a contrast between coronal tap and trill

<table>
<thead>
<tr>
<th>Typological Patterns</th>
<th>Languages</th>
</tr>
</thead>
</table>
| Pattern I:           | Basque (Basque)  
| Contrast intervocally | Catalan (Iberian Romance)  
|                      | European Portuguese (Non-standard dialects with alveolar trill; Iberian Romance)  
|                      | Sebei (Nilotic)  
|                      | Spanish (Standard dialects with alveolar trill; Iberian Romance)  
| Pattern II:          | Kaliai-Kove (Austronesian: Western Oceanic)  
| Contrast intervocally and word-initially | Palauan (Austronesian: Malayo-Polynesian)  
| Pattern III:         | Kairiru (Austronesian: Western Oceanic)  
| Contrast intervocally, word-initially, and in heterorganic clusters and word-finally | Kurdish (Indo-Iranian)$^{63}$  
|                      | Ngizim (West Chadic)  

Table 4–2 completes the typological picture by illustrating the realizations of rhotics in environments where contrast is neutralized:

Table 4–2: A typology of word-level rhotic duration contrast and neutralization

<table>
<thead>
<tr>
<th>V_V</th>
<th>#_V</th>
<th>Heterorganic Clusters, V_#</th>
<th>Homorganic Clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basque</td>
<td>contrast</td>
<td>trill</td>
<td>trill</td>
</tr>
<tr>
<td>Iberian Romance</td>
<td>contrast</td>
<td>trill</td>
<td>tap/trill</td>
</tr>
<tr>
<td>Sebei</td>
<td>contrast</td>
<td>tap</td>
<td>tap</td>
</tr>
<tr>
<td>Kaliai-Kove</td>
<td>contrast</td>
<td>contrast</td>
<td>trill</td>
</tr>
<tr>
<td>Palauan</td>
<td>contrast</td>
<td>contrast</td>
<td>tap</td>
</tr>
<tr>
<td>Kairiru</td>
<td>contrast</td>
<td>contrast</td>
<td>contrast</td>
</tr>
<tr>
<td>Ngizim</td>
<td>contrast</td>
<td>contrast</td>
<td>contrast</td>
</tr>
<tr>
<td>Kurdish</td>
<td>contrast</td>
<td>trill</td>
<td>contrast</td>
</tr>
</tbody>
</table>

$^{63}$ In Kurdish, tap and trill are contrastive intervocally, in heterorganic clusters, and word-finally, but only trill appears word-initially. See below for discussion.
Once Iberian Romance is viewed from a broader cross-linguistic perspective in Table 4–2, several typological generalizations emerge regarding positions of contrast and neutralization. First, languages with contrastive tap and trill appear to be situated along a continuum of positional contrast maintenance. There is an implicational relation among contrastive positions, as illustrated by the hierarchy in (4.1):

\[
\begin{align*}
\text{Position 1} & \quad < \quad \text{Position 2} & \quad < \quad \text{Position 3} \\
\text{Intervocalic} & \quad < \quad \text{Word-initial} & \quad < \quad \text{Heterorganic clusters, Word-final}
\end{align*}
\]

where contrast in Position x entails contrast in Position y iff y < x.

If rhotic duration contrast is maintained in a given position within the hierarchy in (4.1), then contrast is also maintained in positions to the left. An obvious exception is Kurdish, in which the tap and trill contrast in Positions 1 and 3 but not in Position 2, where the trill is obligatory. In Section 4.4.3, I argue that this is only an apparent exception and demonstrate how neutralization to trill in word-initial position makes the Kurdish system harmonically incomplete in the sense of Prince and Smolensky (1993:185).

Table 4–2 reveals several generalizations with respect to the positional neutralization of contrast, as shown in (4.2):
a. Neutralization affects other positions within the word before it affects intervocalic position. Contrast is maintained between vowels in all of the languages surveyed.

b. In most of the languages surveyed, word-initial position either maintains contrast or exhibits neutralization to trill.

c. Word-initial tap entails taps also in heterorganic clusters and word-finally, as shown in Sebei. In contrast, word-initial trill does not entail obligatory trills in heterorganic clusters nor word-finally. This is demonstrated by Iberian Romance and Kurdish, in which the trill surfaces word-initially, while both the tap and trill surface in heterorganic clusters and word-finally—non-contrastively in Iberian Romance versus contrastively Kurdish.

d. Neutralization treats word-final position and heterorganic clusters as a natural class. No language neutralizes contrast in heterorganic clusters without also neutralizing it in word-final position, and vice-versa.

e. Rhotics do not cluster with homorganic consonants in six of the languages surveyed. In the remaining languages, the trill is obligatory under several types of coronal-adjacent configurations. Contrast is never allowed in homorganic clusters in any of the languages surveyed.

The theoretical goal of this chapter is to demonstrate how these generalizations are accounted for by the phonetically-based OT analysis developed in Chapter 3. In the following section, I show how each of the above generalizations follows as a consequence of constraint interaction.

### 4.1 Typology of Constraint Rankings

One of the central claims of OT is that variation across languages follows from constraint ranking. Specifically, a typology of predicted grammars constitutes the set of distinct grammars predicted by different rankings of the same set of constraints. I argue that typological patterns shown in Table 4–2 reflect different possible grammars, as predicted
by the rankings of three basic constraint types: the *FAST family, which favors the trill, *HOLD, which favors the tap, and the CONTRAST(duration) hierarchy, which prefers that the two rhotics be phonologically contrastive.

The first generalization in (4.2) is that all of the surveyed languages minimally exhibit intervocalic contrast. This stems from the dominance of CONTRAST(dur/V_V) over the markedness constraints with which it interacts, namely *FAST and *HOLD, as shown in (4.3):

( 4.3 ) Constraint ranking affecting intervocalic position

<table>
<thead>
<tr>
<th>CONTRAST(dur/V_V)</th>
<th>Intervocalic contrast:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in all languages surveyed</td>
</tr>
<tr>
<td>*FAST,</td>
<td></td>
</tr>
<tr>
<td>*HOLD</td>
<td></td>
</tr>
</tbody>
</table>

While the lower-ranked constraints of the CONTRAST(duration) hierarchy may be dominated by relevant markedness constraints, the highest-ranked CONTRAST(dur/V_V) is always undominated in languages that have a contrast between the tap and trill.

Otherwise, there would be absolute neutralization of the contrast, and the surface realization of rhotics would be determined solely by markedness constraints.

Second, word-initial position typically either maintains contrast or exhibits neutralization to trill. This follows from the high ranking of CONTRAST(dur/#_V) in the former case and of *FAST/INITIAL in the latter, as shown in (4.4):
(4.4) Constraint rankings affecting word-initial position

a. CONTRAST(dur/#_V)  
   |  FAST/INITIAL,  
   |  HOLD  
   Word-initial contrast:  
   Kaliai-Kove, Palauan, Kairiru, Ngizim

b. FAST/INITIAL  
   |  CONTRAST(dur/#_V),  
   |  HOLD  
   Word-initial trill:  
   Basque, Iberian Romance, Kurdish

Now, when *HOLD outranks CONTRAST(dur/#_V), it also outranks—by transitivity of constraint ranking—the context-free CONTRAST(dur). This transitivity relation is a consequence of the universal CONTRAST(duration) hierarchy, in which CONTRAST(dur/#_V) dominates CONTRAST(dur). If *HOLD dominates the former constraint, then it necessarily also dominates the latter, as shown in (4.5):

(4.5) Constraint ranking affecting non-intervocalic positions

*HOLD  
   |  CONTRAST(dur/#_V),  
   |  FAST/INITIAL  
   |  CONTRAST(dur),  
   |  FAST  
   Non-intervocalic tap:  
   Sebei

Although the positional *FAST/INITIAL is shown to dominate the context-free *FAST in (4.5), their ranking is actually irrelevant. As long as *HOLD is dominant in the hierarchy, the effects of these two lower-ranked *FAST constraints will not be seen. That is to say,

---

64 See Section 3.2.1 of Chapter 3 for motivation of the universal ranking of CONTRAST(duration) constraints in terms of harmonic alignment.
the rankings of *HOLD » *FAST/INITIAL » *FAST and *HOLD » *FAST » *FAST/INITIAL are non-distinct in that both yield the same result, namely tap in word-initial position, in heterorganic clusters, and in word-final position.

The ranking in (4.5) captures the third generalization regarding neutralization, namely that word-initial tap entails taps also in heterorganic clusters and word-finally. More specifically, this generalization follows from the fact that *HOLD is the only constraint that could be responsible for word-initial neutralization to tap because there is no constraint such as *HOLD/INITIAL. In contrast, word-initial trill does not entail obligatory trills in heterorganic clusters nor word-finally. In the ranking in (4.4b), the positional constraint *FAST/INITIAL ensures word-initial trills, but nothing prevents lower-ranked *FAST from interacting with the other context-free constraints *HOLD and CONTRAST(duration), thereby generating different patterns in heterorganic clusters and word-finally.

Fourth, neutralization treats word-final position and heterorganic clusters as a natural class in that absence of contrast in the former entails absence of contrast in the latter, and vice-versa. This is exactly because there is no constraint that distinguishes between word-final position and heterorganic clusters. Since neutralization in one of these contexts is due to the context-free markedness constraints *HOLD and *FAST, the other context is automatically implicated because there is no contrast constraint specific to either of the two contexts. Three scenarios are possible for these positions, as determined by the rankings of the context-free constraints in (4.6):
Constraint rankings affecting heterorganic clusters and word-final position

a. \( \text{CONTRAST(dur)} \)
   | *\text{HOLD},
   | *\text{FAST}

b. *\text{HOLD}
   | \text{CONTRAST(dur)},
   | *\text{FAST}

c. *\text{FAST}
   | \text{CONTRAST(dur)},
   | *\text{HOLD}

In Chapter 3, it was argued that the ranking in (4.6b) characterizes those dialects of European Portuguese with alveolar trills, in which only the tap appears in heterorganic clusters and word-finally. On the other hand, the realization of Spanish and Catalan rhotics varies between the tap and trill in these contexts, which suggests that *\text{HOLD} and *\text{FAST} are unranked with respect to each other but that they both dominate \text{CONTRAST(duration)}. (See Section 3.3.3 of Chapter 3 for the specifics of the analysis.)

The final generalization is that contrast is never allowed in homorganic clusters, where neutralization to trill is obligatory. This follows from the ranking of *\text{FAST/SAME SITE} above the other context-free constraints, shown in (4.7):

\[
\text{(4.7)} \quad *\text{FAST/SAME SITE} \quad \text{Trill in Place-sharing clusters:} \\
\text{Iberian Romance, Kairiru, Ngizim}
\]

This ranking is assumed to hold for all the languages of the rhotic duration typology, although its effects are not visible in languages where rhotics do not surface in Place-
sharing clusters. In fact, there are six languages in Table 4–2 in which the *FAST/SAME SITE constraint ensures the trill under Place-sharing. With respect to Iberian Romance (i.e., Catalan, European Portuguese, and Spanish), it was argued in Section 3.3.3 of Chapter 3 that the trill is obligatory after alveolar consonants due to Place/stricture-sharing, whereas the tap is possible preconsonantally because rhotic + consonant clusters do not share Place. In Section 4.4.1 below, we will see that Kairiru resembles Iberian Romance with respect to neutralization to trill after alveolar consonants. In Section 4.4.2, preconsonantal rhotics in Ngizim are argued to share Place with a following alveolar noncontinuant, but not with other consonants. In all of these cases, *FAST/SAME SITE guarantees neutralization to trill in Place/stricture-sharing configurations.

In the remaining sections of this chapter, I illustrate the constraint rankings in (4.3) through (4.7) on a language-by-language basis. After an initial review of the analysis proposed in Chapter 3 for Iberian Romance, subsequent sections demonstrate how different rankings predict the remaining typological patterns shown in Table 4–2.

4.2 Pattern I: Intervocalic Contrast

*Table 4–3* below summarizes the word-level rhotic pattern in Spanish, with examples from the data presented in Chapter 2:
The Catalan tap and trill were shown to exhibit a pattern similar to that of Spanish. However, for those European Portuguese varieties with alveolar trills, only the tap surfaces after heterorganic consonants, before any consonant, and word-finally. In Section 3.3 of Chapter 3, the rankings in (4.8) were shown to account for these patterns.

Table 4–3: Word-level distribution of rhotics in Spanish

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td><em>pe</em>[r]o</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>pe</em>[r]o</td>
</tr>
<tr>
<td>After homorganic consonant</td>
<td>trill</td>
<td><em>hon</em>[r]a</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>al</em>[r]ededor</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Is</em>[r]ael</td>
</tr>
<tr>
<td>Word-initial</td>
<td></td>
<td>*[r]osa</td>
</tr>
<tr>
<td>After heterorganic consonant</td>
<td>tap</td>
<td><em>t</em>[r]es</td>
</tr>
<tr>
<td>(trill only in highly emphatic</td>
<td></td>
<td><em>b</em>[r]azo</td>
</tr>
<tr>
<td>speech)</td>
<td></td>
<td><em>c</em>[r]ea</td>
</tr>
<tr>
<td>Before any consonant</td>
<td></td>
<td><em>ma</em>[r ~ r]tes</td>
</tr>
<tr>
<td>stylistically-controlled variation</td>
<td></td>
<td><em>ma</em>[r ~ r] verde</td>
</tr>
<tr>
<td>Word-final</td>
<td></td>
<td><em>ma</em>[r ~ r]</td>
</tr>
</tbody>
</table>

This summary does not show the phonological behavior of rhotics at the phrasal level, and the examples are assumed to represent words in isolation. Although the phrasal phonology of tap and trill has been thoroughly investigated in studies focusing on Iberian Romance languages, the data sources for other languages typically fail to discuss phrase-medial contexts such as word-initial postvocalic or word-final prevocalic. Therefore, the empirical survey of this chapter focuses on rhotic patterns only at the word level.
Basic constraint rankings for word-level patterns observed in Iberian Romance varieties with alveolar trill

a. Spanish and Catalan
   \[
   \text{CONTRAST}(\text{dur/V}_V),
   \quad \*\text{FAST/INITIAL}
   \]
   \[
   \text{CONTRAST}(\text{dur#}_V),
   \quad \*\text{FAST/SAME}
   \]
   \[
   \*\text{HOLD},
   \quad \*\text{FAST}
   \]
   \[
   \text{CONTRAST}(\text{dur})
   \]

b. European Portuguese
   \[
   \text{CONTRAST}(\text{dur/V}_V),
   \quad \*\text{FAST/INITIAL}
   \]
   \[
   \text{CONTRAST}(\text{dur#}_V),
   \quad \*\text{FAST/SAME}
   \]
   \[
   \*\text{HOLD}
   \]
   \[
   \*\text{FAST,}
   \quad \text{CONTRAST}(\text{dur})
   \]

There are at least two documented languages outside of the Iberian Romance family in which the coronal tap and trill are in contrast only intervocalically within the word. The following sections present analyses of data from Basque and Sebei, which differ from Iberian Romance with respect to patterns of neutralization. We will see that these differences are exactly what we should expect under different rankings of the same constraints that account for Spanish, Catalan, and European Portuguese.

4.2.1 Basque

Basque is spoken in an area located on both the French and Spanish sides of the western Pyrenees. As demonstrated by the examples in Table 4–4, the alveolar tap and trill contrast intervocalically in this language, while only the trill occurs elsewhere. (N.B.: The examples are representative rather than exhaustive. Data sources are abbreviated, and specific page numbers of the works are indicated.)
Table 4–4: Rhotic distribution in Basque (Hualde [H] 1991; Saltarelli [S] 1988)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td>e[ɾ]e</td>
<td>'also'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>e[ɾ]e</td>
<td>'to burn'</td>
</tr>
<tr>
<td>Word-initial</td>
<td></td>
<td>[ɾ]adar</td>
<td>'radar'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ɾ]azionalizazio</td>
<td>'rationalization'</td>
</tr>
<tr>
<td>After consonant</td>
<td>trill</td>
<td>[pr]antziar</td>
<td>'French'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>an[ɾ]e</td>
<td>'woman'</td>
</tr>
<tr>
<td>Before consonant</td>
<td></td>
<td>a[ɾ]o</td>
<td>'corn'</td>
</tr>
<tr>
<td></td>
<td></td>
<td>no[ɾk]</td>
<td>'who–ERG'</td>
</tr>
</tbody>
</table>

4.2.1.1 Observations

Like Iberian Romance, Basque permits the tap and trill to contrast between vowels, but only the trill surfaces in non-intervocalic positions. None of the examples in Hualde (1991) and Saltarelli (1988) show rhotics clustering with homorganic consonants.

In the native Basque lexicon, rhotics do not occur word-initially. Early lexical borrowings of trill-initial words from Spanish and Latin-Romance resulted in the insertion of a prothetic vowel, "a strategy which is indicative of the absence of initial vibrants at the time of contact" (Saltarelli 1988:276). The examples in (4.9) show how the prothetic vowel served to circumvent the prohibition against initial rhotics:

<table>
<thead>
<tr>
<th>Basque</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>e[r]epublika</td>
<td>Sp. [r]epublica</td>
</tr>
<tr>
<td>e[r]espuesta</td>
<td>Sp. [r]espuesta</td>
</tr>
<tr>
<td>e[r]espeto</td>
<td>Sp. [r]espeto</td>
</tr>
<tr>
<td>a[r]atoi</td>
<td>Sp. [r]atón 'mouse'</td>
</tr>
<tr>
<td>a[r]opa</td>
<td>Sp. [r]opa</td>
</tr>
<tr>
<td>a[r]aza</td>
<td>Sp. [r]aza</td>
</tr>
<tr>
<td>a[r]oka</td>
<td>Rom. [r]oka–</td>
</tr>
<tr>
<td>e[r]ege</td>
<td>Rom. [r]ege–</td>
</tr>
</tbody>
</table>

More recent borrowings, such as *radar 'radar' and razionalizazio 'rationalization'
in Table 4–4, do permit word-initial trills, but native speakers recognize them as borrowings. Nonetheless, words such as these suggest that although the former prohibition against word-initial rhotics is no longer as stringent in contemporary Basque, there is still a restriction against word-initial taps, given that *[r]adar and *[r]azionalizazio are unattested realizations.

Although all word-final rhotics are neutralized to trill at the phonetic surface, Hualde (1991:13) notes that stem-final contrast is possible. The addition of a vowel-initial suffix to a rhotic-final stem has the effect of placing the rhotic in the contrastive intervocalic position, as seen in (4.10):

(4.10) Stem-final contrast revealed by suffixation in absolutive singular forms (Hualde 1991:13)

<table>
<thead>
<tr>
<th>Uninflected</th>
<th>Absolutive singular</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ur/ 'water'</td>
<td>[ur]</td>
</tr>
<tr>
<td>/ur/ 'hazelnut'</td>
<td>[ur]</td>
</tr>
</tbody>
</table>
4.2.1.2 Analysis

Like Iberian Romance varieties, Basque combines the rankings in (4.3) and (4.4b), which ensure intervocalic contrast and word-initial trills, respectively. In contrast, Basque favors the trill in heterorganic clusters and word-finally by ranking *FAST above CONTRAST(dur) and *HOLD, as in (4.6c). The complete ranking is shown in (4.11):

\[
\begin{align*}
\text{CONTRAST(dur/V\_V)}, & \\
\ast\text{FAST/INITIAL}, & \\
\ast\text{FAST/SAME} &
\end{align*}
\]
\[
\begin{array}{c}
| \\
\text{CONTRAST(dur\#\_V)}, & \\
\ast\text{FAST} &
\end{array}
\]
\[
\begin{array}{c}
| \\
\text{CONTRAST(dur)}, & \\
\ast\text{HOLD} &
\end{array}
\]

Tableau (4.12) below illustrates how this ranking generates the Basque pattern. Since there are no examples in Hualde (1991) and Saltarelli (1988) to suggest that rhotics cluster with homorganic consonants, the *FAST/SAME SITE constraint does not have any visible effects and is, therefore, omitted from the tableau.
In this predicted grammar, intervocalic contrast is preserved in candidate (a), while the contrast is neutralized to trill in all other positions: word-initially (f), in heterorganic clusters (i,l), and word-finally (o).

As evidenced by the forms in (4.10), stem-final contrast is recovered when a vowel suffix is added, but neutralized to trill when the rhotic is word-final. This alternation follows from the proposed constraint hierarchy, as shown in tableau (4.13):
(4.13) Stem-final contrast revealed by suffixation in absolutive singular forms ([ura] vs. [ura]) but neutralized in uninflected forms ([ur])

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/V_V)</th>
<th>*FAST/INITIAL</th>
<th>CONTRAST (dur/#_V)</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>ura ≠ ura</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>b.</td>
<td>ura</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>ura</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>d.</td>
<td>ur^u# ≠ ur#</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>ur^u#</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>ur#</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

The inflected forms in candidate (a) are phonologically contrastive, as ensured by CONTRAST(dur/V_V). In uninflected forms, however, the stem-final rhotic is also word-final, as seen in candidates (d–f). *FAST guarantees neutralization to trill in this position, which makes the surface forms of these two words homophonic in candidate (f).

4.2.2 Sebei

Sebei is an Eastern Sudanic language of the Nilotic family and is spoken by approximately 40,000 people in Eastern Uganda and Western Kenya. According to O'Brien and Cuypers (1975:8), both the alveolar tap and trill occur contrastively between vowels within the word, while only the tap occurs elsewhere.66

66 O'Brien and Cuypers refer to the shorter rhotic as an alveolar flap. For consistency, however, I continue to refer to this segment as a tap.
Table 4–5: Rhotic distribution in Sebei (O’Brien and Cuypers 1975)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td><em>ko[r]om</em> 'hard, tough'</td>
<td>p. 125</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>ko[r]on</em> 'early in the morning'</td>
<td></td>
</tr>
<tr>
<td>Word-initial</td>
<td>tap</td>
<td><em>[r]emput</em> 'lips'</td>
<td>pp. 160, 162</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>[r]uket</em> 'walking stick'</td>
<td></td>
</tr>
<tr>
<td>After consonant</td>
<td>tap</td>
<td><em>tam[pr]et</em> 'a ten-cent piece'</td>
<td>pp. 119, 171, 181</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>kap[t]ok</em> 'rubbish pit'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>yang[kr]an</em> 'excrete'</td>
<td></td>
</tr>
<tr>
<td>Before consonant</td>
<td></td>
<td><em>ku[rp]atit</em> 'young leopard'</td>
<td>pp. 111, 119, 128</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>a[r]am</em> 'forty'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>ka[rk]eyey</em> 'be the same'</td>
<td></td>
</tr>
<tr>
<td>Word-final</td>
<td></td>
<td><em>kame[r]</em> 'lay hands on'</td>
<td>pp. 118, 179</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>wi[r]</em> 'trunk'</td>
<td></td>
</tr>
</tbody>
</table>

4.2.2.1 Observations

Like Iberian Romance and Basque, Sebei preserves contrast intervocally. However, Sebei differs from Basque in that only the tap surfaces in non-intervocalic positions. Given that all other coronal consonants in the language are dental, Sebei lacks homorganic clusters involving rhotics (O'Brien and Cuypers 1975:7–8).

4.2.2.2 Analysis

In Sebei, CONTRAST(dur/V_V) ranks higher than the conflicting markedness constraints *HOLD and *FAST, thereby ensuring intervocalic contrast between the tap and trill.
Neutralization to tap in all other positions is guaranteed by the ranking of *HOLD above those constraints relevant to word-initial position, heterorganic clusters, and word-final position. As noted above in the discussion surrounding (4.5), the prediction is that the presence of word-initial tap should also entail the presence of taps in other positions—exactly the pattern observed in *Table 4–5*. The complete ranking for Sebei is shown in (4.14):

(4.14)  Constraint ranking for Sebei

\[
\begin{align*}
\text{CONTRAST(dur/V\_V),} & \quad \ast\text{FAST/SAME} \\
& \quad \ast\text{HOLD} \\
& \quad \text{CONTRAST(dur\#\_V),} \\
& \quad \ast\text{FAST/INITIAL} \\
& \quad \text{CONTRAST(dur),} \\
& \quad \ast\text{FAST}
\end{align*}
\]

Tableau (4.15) shows how the high-ranking *HOLD constraint enforces neutralization to tap in all non-intervocalic positions. Since Sebei lacks homorganic clusters involving rhotics, *FAST/SAME SITE is omitted from the tableau.
(4.15) Intervocalic contrast but neutralization to tap elsewhere in Sebei

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/V_V)</th>
<th>*HOLD</th>
<th>CONTRAST (dur/#_V)</th>
<th>*FAST/INITIAL</th>
<th>CONTRAST (dur)</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>VrV ≠ VrV</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>VrV</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>VrV</td>
<td>!</td>
<td>**</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>#rV ≠ #rV</td>
<td>!!*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>#rV</td>
<td>!!*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>#rV</td>
<td>!!*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td>CrV ≠ CrV</td>
<td>!!*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>CrV</td>
<td>!!*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>CrC</td>
<td>!!*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td>VrC ≠ VrC</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k.</td>
<td>VrC</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l.</td>
<td>VrC</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m.</td>
<td>Vr# ≠ Vr#</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n.</td>
<td>Vr#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This ranking of the constraints predicts intervocalic contrast (a) versus neutralization to tap word-initially (e), in heterorganic clusters (h,k), and word-finally (n). As shown in the winning candidates for non-intervocalic positions, the dominant position of *HOLD in the hierarchy makes irrelevant the violations of both the word-initial and the context-free constraints. It is thus impossible for the trill to surface in heterorganic clusters or word-finally if only the tap surfaces word-initially. This type of pattern is, to my knowledge, unattested cross-linguistically.

It is worth reiterating here that other logically possible patterns of positional neutralization to tap are empirically unattested precisely because *HOLD is the only
markedness constraint against the trill. Since there is no *HOLD/INITIAL, the only way to ensure word-initial neutralization to tap is to rank *HOLD above *FAST/INITIAL, *FAST, CONTRAST(dur/#_V), and CONTRAST(dur). The relative ranking of the context-specific and context-free *FAST constraints within this lower-ranked group is irrelevant, since context-free *HOLD is dominant. Moreover, since there is no constraint such as
*FAST/DIFFERENT SITE or *FAST/V_#, the already-established ranking of *HOLD » *FAST explains why heterorganic clusters and word-final position, respectively, are never singled out over other positions for neutralization to trill.

4.3 Pattern II: Intervocalic and Word-initial Contrast

The languages examined so far in this survey maintain contrast between the coronal tap and trill only between vowels within the word. The Austronesian languages Kaliai-Kove and Palauan both go one step beyond by allowing the contrast to be preserved in word-initial position as well as intervocally.67

67 At least two other languages have been reported to have a tap/trill contrast between vowels and word-initially: Guajiro (Mansen 1967) and Malayalam (Kumari 1973). Subsequent research suggests, however, that in both languages, the relevant contrast is one not of duration but of manner and/or place. Guajiro contrasts a lateral flap with an alveolar trill (Alvarez 1986). In Malayalam, one rhotic is a palatalized dental, while the other is an uvularized alveolar (McAlpin 1998). Therefore, these languages are excluded from the present investigation because duration is not the relevant dimension of contrast.
4.3.1 Kalai-Kove

Kalai-Kove is a language of the Western Oceanic branch of the Austronesian family. It is spoken in the west New Britain district of the Territory of Papua and New Guinea. Data examined in this section are from the Kandoka-Lusi dialect, which is spoken on the North Coast of New Britain Island (Counts 1969). While the tap and trill contrast intervocally and word-initially, only the trill surfaces in clusters and word-finally.

Table 4–6: Rhotic distribution in Kalai-Kove (Counts 1969)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td>[thuˈɜura] 'bullroarer; our ancestors'</td>
<td>pp. 45, 46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[thuˈɜuru] 'place, area, location'</td>
<td></td>
</tr>
<tr>
<td>Word-initial</td>
<td></td>
<td>[rai] 'frigate bird'</td>
<td>pp. 45, 46</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[raila] 'place, area, location'</td>
<td></td>
</tr>
<tr>
<td>After consonant</td>
<td>trill</td>
<td>[ɣrem] 'somewhat, slightly'</td>
<td>p. 22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[mokrup] 'frog'</td>
<td></td>
</tr>
<tr>
<td>Before consonant</td>
<td>trill</td>
<td>[iɣaryare] 'he copulates (durative)'</td>
<td>pp. 20, 53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[mˈbarku] 'spirit mask type'</td>
<td></td>
</tr>
<tr>
<td>Word-final</td>
<td></td>
<td>[napar] 'dog's tooth net bag'</td>
<td>p. 48</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[tʰaˈʃur] 'trumpet'</td>
<td></td>
</tr>
</tbody>
</table>

4.3.1.1 Observations

The form [iɣaryare] 'he copulates (durative)' shown in Table 4–6 is the result of a reduplication process. This makes [ɣrem] 'somewhat, slightly', [mokrup] 'frog', and [mˈbarku] 'spirit mask type' the only three attested examples of clusters involving a
trill and an adjacent consonant which are not created by reduplication (see Counts 1969:18–20). Rhotics do not cluster with homorganic consonants in this language.

4.3.1.2 Analysis

The preservation of contrast intervocally and word-initially in Kaliai-Kove stems from the dominance of CONTRAST(dur/V_V) and CONTRAST(dur/#_V). Neutralization to trill in all other positions is ensured by the ranking of *FAST over CONTRAST(dur) and *HOLD. The complete ranking for Kaliai-Kove is shown in (4.16):

\[
\text{(4.16) Constraint ranking for Kaliai-Kove}
\]

\[
\begin{align*}
\text{CONTRAST(dur/V_V)} \\
\text{CONTRAST(dur/#_V)} \\
*\text{FAST/INITIAL,} \\
*\text{FAST/SAME,} \\
*\text{FAST} \\
\text{CONTRAST(dur),} \\
*\text{HOLD}
\end{align*}
\]

Tableau (4.17) shows how the above constraint ranking makes the correct predictions for different positions within the word. As in the case of Basque and Sebei above, *FAST/SAME SITE is omitted from the tableau since Kaliai-Kove lacks homorganic clusters involving rhotics.
(4.17) Intervocalic and word-initial contrast, but neutralization to trill elsewhere in Kaliai-Kove

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
 & \text{CONTRAST (dur/V/V)} & \text{CONTRAST (dur/#_V)} & \text{*FAST/INITIAL} & \text{*FAST} & \text{CONTRAST (dur)} & \text{*HOLD} \\
\hline
a. & VrV ≠ VrV & & * & & * & ** \\
b. & VrV & *! & & * & & * \\
c. & VrV & *! & & & & * & ** \\
d. & #^\text{r}rV ≠ #rV & & * & * & & ** \\
e. & #^\text{r}rV & *! & * & * & * \\
f. & #rV & *! & & * & & * & ** \\
g. & C^\text{r}rV ≠ CrV & & *! & & * & ** \\
h. & C^\text{r}rV & *! & & & * \\
i. & CrV & & & & * & ** \\
j. & Vr^\text{v}C ≠ VrC & & *! & & * \\
k. & Vr^\text{v}C & *! & & * \\
l. & VrC & & & & * & * \\
m. & Vr^\text{v}# ≠ Vr# & & *! & & * \\
n. & Vr^\text{v}# & *! & & * \\
o. & Vr# & & & & * & * \\
\hline
\end{array}
\]

In this grammar, contrast is preserved intervocally (a) and word-initially (d), while contrast is neutralized to trill in heterorganic clusters (i,l), and word-finally (o). Kaliai-Kove resembles Basque with respect to the ranking of *FAST over CONTRAST(dur) and *HOLD. However, Kaliai-Kove differs from Basque in that *FAST/INITIAL is dominated by CONTRAST(dur/#_V).
4.3.2 Palauan

Palauan belongs to the Austronesian language family within the western Malayo-Polynesian branch. In this language, the tap and trill are in contrast intervocally and word-initially. However, only the tap surfaces in other positions within the word (Hagège 1986; Josephs 1990).

Table 4–7: Rhotic distribution in Palauan (Josephs 1990)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td><em>me[r]a[kl]</em> 'to pick up out of pot'</td>
<td>pp. 188, 193</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>me[r]a[kl]</em> 'to destroy; dismantle'</td>
<td></td>
</tr>
<tr>
<td>Word-initial</td>
<td>contrast</td>
<td><em>[r]u[u]l</em> 'type of fishnet made of palm leaves'</td>
<td>pp. 295, 296</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>[r]u[u]l</em> 'made; done; prepared'</td>
<td></td>
</tr>
<tr>
<td>After consonant</td>
<td>tap</td>
<td><em>o[mr]a[lm]</em> 'rinse'</td>
<td>pp. 27, 261, 268</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>[pr]e[r]</em> 'raft'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>o[r][ŋ]a[o]l</em> 'starchy food'</td>
<td></td>
</tr>
<tr>
<td>Before consonant</td>
<td>tap</td>
<td><em>cha[rm]</em> 'animal; bug; insect'</td>
<td>pp. 35, 39, 83</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>do[r{t}]</em> 'ironwood tree'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>chede[rŋ]o[r]</em> 'type of trepang'</td>
<td></td>
</tr>
<tr>
<td>Word-final</td>
<td>tap</td>
<td><em>de[r]</em> 'remainder, leftovers'</td>
<td>pp. 76, 124</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>klemu[r]</em> 'dried tail of rayfish'</td>
<td></td>
</tr>
</tbody>
</table>

4.3.2.1 Observations

Palauan resembles Sebei regarding neutralization to tap in non-contrastive positions.

With respect to clusters, Hagège (1986) notes that "la langue tend à éviter les
combinaisons de consonnes homorganiques [The language tends to avoid combinations of homorganic consonants—TGB]" (22). Nonetheless, there are many words in which the tap surfaces before the alveolar fricative [s], some of which are given in (4.18):

(4.18) Tap + alveolar fricative clusters in Palauan (Josephs 1990)

- che[rs]uuch 'dolphin fish; mahi-mahi' (p. 54)
- de[rs]tang 'once in a while' (p. 77)
- ke[rs]os 'yearning; anxious' (p. 114)
- se[rs] 'garden; farm; fence' (p. 305)

In Section 3.3.3 of Chapter 3, it was argued that rhotic + consonant sequences in Iberian Romance are not Place/stricture-sharing clusters. I make the same assumption here, thereby grouping the [rs] clusters of (4.18) with heterorganic ones such as those in cha[rm] 'animal; bug; insect', do[rṭ h] 'ironwood tree', and chede[rn] or 'type of trepang' in Table 4–7.

One interesting phonotactic possibility in Palauan is that a sonorant consonant may precede another consonant word-initially, in which case the sonorant is syllabic. This is illustrated by the data in (4.19):

(4.19) Word-initial sonorant consonants are syllabic before other consonants in Palauan (Josephs 1990 [J]; Hagège 1986 [H])

- mchiielak [m̩i?iyolak h] 'wait for me!' (J: p. xl)
- nglim [ηlim] 'drunk (up)' (J: p. xl)
- ltel [t̃l̃] 'his return' (J: p. xl)
- rsechek [r̃soʔek h] 'my blood' (J: p. xl)
- rtangel [r̃t̃aŋ̃al] 'is to be pounded' (J: p. xl)
- rsmem [r̃sm̃em] 'your needle' (H: p. 23)
According to Josephs (1990:xl), syllabic word-initial rhotics, such as those of the last three examples in (4.19), may be pronounced as trills by some speakers. Therefore, I assume that the tap and trill are in free variation word-initially before a consonant. This contrasts with word-initial prevocalic position, in which the tap and trill occur contrastively, as shown by examples such as [r]uul 'type of fishnet made of palm leaves' versus [r]uul 'made; done; prepared' in Table 4–7.

4.3.2.2 Analysis

The constraints ensuring intervocalic and word-initial contrast are dominant in Palauan, just like they are in Kaliai-Kove. *HOLD outranks CONTRAST(dur) and *FAST, thereby guaranteeing neutralization to tap in other positions, as in Sebei. The complete ranking for Palauan is shown in (4.20), and the evaluation is shown in tableau (4.21) below:

(4.20) Constraint ranking for Palauan

```
| CONTRAST(dur/V_V) |
| CONTRAST(dur#_V) |
| *FAST/SAME, |
| *FAST/INITIAL, |
| *HOLD |
| CONTRAST(dur), |
| *FAST |
```
(4.21) Intervocalic and word-initial contrast, but neutralization to tap elsewhere in Palauan

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/V_V)</th>
<th>CONTRAST (dur/#_V)</th>
<th>*FAST/INITIAL</th>
<th>*HOLD</th>
<th>CONTRAST (dur)</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>VrV ≠ VrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b</td>
<td>VrV</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>VrV</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>#v rV ≠ #rV</td>
<td></td>
<td>*</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e</td>
<td>#v rV</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>#v rV</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>g</td>
<td>CrV ≠ CrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>CrV</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>CrV</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>j</td>
<td>Vr'C ≠ VrC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k</td>
<td>Vr'C</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>VrC</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>m</td>
<td>Vr'# ≠ Vr#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>Vr'#</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

This above ranking predicts contrast intervocalically (a) and word-initially before vowel (b), while the tap is predicted to surface in heterorganic clusters (h,k) and word-finally (n).

The same ranking of constraints adequately captures the behavior of word-initial preconsonantal rhotics, whose realization varies freely between the tap and trill (see the data in (4.19) and the surrounding discussion). Tableau (4.22) shows how contrast is allowed word-initially before vowels, while free variation occurs word-initially before consonants:
Contrast word-initially before vowel ([r]uul vs. [r]uul), but free variation word-initially before consonant ([r ~ r]sm-em)

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/#_V)</th>
<th>*FAST/INITIAL</th>
<th>*HOLD</th>
<th>CONTRAST (dur)</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>☞ a.</td>
<td>[⁴r]uul ≠ [r]uul</td>
<td>*</td>
<td>**</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>☞ b.</td>
<td>[⁴r]uul</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☞ c.</td>
<td>[r]uul</td>
<td>!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>☞ d.</td>
<td>[⁷r³s]mem ≠ [r³s]mem</td>
<td>*</td>
<td></td>
<td>!</td>
<td></td>
</tr>
<tr>
<td>☞ e.</td>
<td>[⁷r³s]mem</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>☞ f.</td>
<td>[r³s]mem</td>
<td></td>
<td>!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

CONTRAST(dur/#_V) preserves contrast in candidate (a) because the word-initial rhotics are prevocalic. This constraint does not apply to candidates (d–f) because the rhotics are preconsonantal in each case. The decision is passed to the lower-ranked *FAST/INITIAL and *HOLD constraints. Since these two constraints are unranked with respect to each other, they collectively rule out the contrastive candidate (d), but fail to distinguish between (e) and (f). As a result, the tap and trill are predicted to vary freely in word-initial preconsonantal position.68

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68 Eric Bakovic (personal communication) suggests a possible alternative analysis in which the constraints at hand simply predict neutralization to tap, due to the ranking of *HOLD » *FAST/INITIAL, while a trilled pronunciation is possible because of the inherent duration of syllabic consonants.
4.4 Pattern III: Contrast Intervocally, Word-initially, and Elsewhere

The final group of languages examined in this survey includes Kairiru, Kurdish, and Ngizim. Each of these languages allows the tap and trill to contrast across-the-board, including in heterorganic clusters and word-finally—except for Kurdish, in which the trill is obligatory word-initially.

4.4.1 Kairiru

Kairiru belongs to the Sepik-Madang subfamily of the Western Oceanic branch of Austronesian languages and is spoken in the East Sepik Province in Papua New Guinea. According to Wivell (1981), Kairiru exhibits a contrast between an alveolar tap and trill, with the tap in free variation with a central approximant \([\bar{r}]\).\(^{69}\) For reasons of simplicity, only the tap is shown in the examples below.

\(^{69}\) Wivell (1981:19) states that alveolar tap is in free variation with a "retroflex 'r'" in all positions. I follow Inouye (1995) in interpreting Wivell's use of the term "retroflex" to mean central approximant:

"'Retroflex' is a term used by many non-phoneticians for the central approximant like that in American English regardless of whether the actual articulation is of the bunched tongue or the sublaminal. That fact and the fact that no other manner of articulation is included in this description of this allophone … lead me to believe that the author is using this traditional terminology" (195).
Table 4–8: Rhotic distribution in Kairiru (Wivell 1981)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>[arųŋ]</td>
<td>'he listens, hears'</td>
<td>pp. 25, 26</td>
</tr>
<tr>
<td></td>
<td>[aruŋ]</td>
<td>'it is finished'</td>
<td></td>
</tr>
<tr>
<td>Word-initial</td>
<td>[ramat’]</td>
<td>'person, male'</td>
<td>pp. 19</td>
</tr>
<tr>
<td></td>
<td>[rakẹŋ]</td>
<td>'councilor; branch'</td>
<td></td>
</tr>
<tr>
<td>After heterorganic consonant</td>
<td>contrast</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[aprimaru]</td>
<td>'he persuades them'</td>
<td>pp. 21, 34</td>
</tr>
<tr>
<td></td>
<td>[forpru]</td>
<td>'spotted snake eel'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[aqrei]</td>
<td>'it is raining'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[qrapʰam]</td>
<td>'your shoulder'</td>
<td></td>
</tr>
<tr>
<td>Before consonant</td>
<td>[korbok’]</td>
<td>'my liver'</td>
<td>pp. 13, 20</td>
</tr>
<tr>
<td></td>
<td>[narbuɔp’]</td>
<td>'butterfly'</td>
<td></td>
</tr>
<tr>
<td>Word-final</td>
<td>[wor]</td>
<td>'crayfish'</td>
<td>p. 20</td>
</tr>
<tr>
<td></td>
<td>[wor]</td>
<td>'banana'</td>
<td></td>
</tr>
<tr>
<td>After homorganic consonant</td>
<td>trill</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[alsru]</td>
<td>'he chops them down'</td>
<td>pp. 32, 33, 35</td>
</tr>
<tr>
<td></td>
<td>[sru]</td>
<td>'pair, brace'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[wuntru]</td>
<td>'I close the door'</td>
<td></td>
</tr>
</tbody>
</table>

4.4.1.1 Observations

The tap and trill are contrastive in all word-level positions in Kairiru except after alveolar consonants, where only the trill occurs, as shown by the last three examples in Table 4–8 above. Wivell (1981) describes both [s] and [t] as alveolar in place of articulation. Given that not a single example in Wivell's descriptive study shows the tap surfacing after homorganic consonants, Kairiru can be argued to parallel Iberian Romance with respect to obligatory postconsonantal trill. In both languages, alveolar consonant + rhotic clusters
involve Place/stricture-sharing configurations—precisely the context in which
*FAST/SAME SITE favors neutralization to trill.

4.4.1.2 Analysis

Thus far in the typological survey, Kairiru is the first language to show evidence of the ranking in (4.6a), in which context-free CONTRAST(dur) dominates *HOLD and *FAST. Together with the ranking of CONTRAST(dur/#_V) over *FAST/INITIAL, this ensures that the tap and trill are generally contrastive in all positions within the word. However, since *FAST/SAME SITE still dominates CONTRAST(dur), neutralization to trill is the expected result in Place/stricture-sharing configurations. The complete ranking for Kairiru in shown in (4.23):

(4.23)  Constraint ranking for Kairiru

```
CONTRAST(dur/V_V)
  | CONTRAST(dur#_V)
  | *FAST/INITIAL,
  | *FAST/SAME
  | CONTRAST(dur)
  | *HOLD,
  | *FAST
```

Tableau (4.24) shows how the CONTRAST(dur) constraints preserve across-the-board contrast between the tap and trill:
### (4.24) Contrast intervocally, word-initially, and elsewhere in Kairiru

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/~V_V)</th>
<th>CONTRAST (dur/~#_V)</th>
<th>*FAST/INITIAL</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>VrV ≠ VrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b.</td>
<td>VrV</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>VrV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>d.</td>
<td>#~rV ≠ #rV</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e.</td>
<td>#~rV</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>#rV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>g.</td>
<td>C~rV ≠ CrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>h.</td>
<td>C~rV</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>CrV</td>
<td>*!</td>
<td>*</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td>Vr~C ≠ VrC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>k.</td>
<td>Vr~C</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l.</td>
<td>VrC</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m.</td>
<td>Vr~# ≠ Vr#</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n.</td>
<td>Vr~#</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o.</td>
<td>Vr#</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This ranking accounts for contrast in all positions: intervocally (a), word-initially (d), in heterorganic clusters (g,j), and word-finally (m).

With respect to postconsonantal rhotics, tableau (4.25) shows how contrast is permitted after heterorganic consonants but neutralized to trill in Place/stricture-sharing configurations:
(4.25) Contrast after heterorganic consonants, but neutralization to trill after homorganic consonants in Kairiru

<table>
<thead>
<tr>
<th></th>
<th>*FAST/SAME</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>C'rV ≠ CrV</td>
<td></td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>C'rV</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>CrV</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>d.</td>
<td>{C'r}V ≠ {Cr}V</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e.</td>
<td>{C'r}V</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>{Cr}V</td>
<td>*</td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>

Since the clusters in candidates (a–c) are do not share Place, *FAST/SAME SITE is irrelevant, and CONTRAST(dur) decides in favor of contrast maintenance (a). The presence of the tap in the Place/stricture-sharing clusters (d,e) does violate *FAST/SAME SITE, which chooses candidate (f), with neutralization to trill, as the winner.

4.4.2 Ngizim

Ngizim is a West Chadic language spoken by 25,000 people in northeast Nigeria. According to Schuh (1981:xi), this language contrasts an alveolar tap and trill in all positions except before coronal stops [t, d, d̪, n] and lateral fricatives [l, ɾ].
Table 4–9: Rhotic distribution in Ngizim (Schuh 1981)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>saa[r]a</td>
<td>'peer'</td>
<td>p. 144</td>
</tr>
<tr>
<td></td>
<td>saa[r]u</td>
<td>'a loan; a thing lent'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[r]akau</td>
<td>'chase away'</td>
<td>p. 136</td>
</tr>
<tr>
<td></td>
<td>[r]akka</td>
<td>'metal anklet for women'</td>
<td></td>
</tr>
<tr>
<td>Word-initial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before heterorganic consonant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ka[rm]u</td>
<td>'cut down'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>kɔ[rm]ai</td>
<td>'chieftainship'</td>
<td>pp. 13, 88, 94, 131, 153, 154</td>
</tr>
<tr>
<td></td>
<td>aata[r]an</td>
<td>'perfume'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>pɔ[r]i</td>
<td>'lip'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tɔ[rk]u</td>
<td>'orphan'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tɔ[rk]akdu</td>
<td>'repeatedly press on'</td>
<td></td>
</tr>
<tr>
<td>Before homorganic continuant cons.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>wu[rz]u</td>
<td>'back'</td>
<td>pp. 17, 99, 173</td>
</tr>
<tr>
<td></td>
<td>bɔ[rz]əŋəlu</td>
<td>'large intestine'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ku[rs]aasiya</td>
<td>'kidney'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bɔ[rz]anzan</td>
<td>'rolling around on the ground'</td>
<td></td>
</tr>
<tr>
<td>Word-final</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>zɔgɔ[r]</td>
<td>'time'</td>
<td>p. 180</td>
</tr>
<tr>
<td></td>
<td>zɔɡa[r]</td>
<td>'north'</td>
<td></td>
</tr>
<tr>
<td>Before homorganic noncontinuant cons.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>trill</td>
<td>sɔ[rt]u</td>
<td>'string beads'</td>
<td>pp. 12, 69, 99, 127, 142</td>
</tr>
<tr>
<td></td>
<td>a[rd]aatu</td>
<td>'agree to, approve of'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ga[rd]u</td>
<td>'cut notch in'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ku[rr]a</td>
<td>'a thorny tree'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ga[r]lə</td>
<td>'strong in taste, bitter'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ngu[r]ədliya</td>
<td>'throat'</td>
<td></td>
</tr>
</tbody>
</table>
4.4.2.1 Observations

Schuh (1981:68) lists only one example in which a rhotic surfaces directly after a consonant: \(ga\)[mr]\(aariyak\) 'completely worn out hoe blade'. The lack of consonant + rhotic clusters in Ngizim is most likely due to the fact that CCV syllables are disallowed and that combinatorial possibilities in heterosyllabic sonorant + sonorant sequences are limited especially when nasals are involved (see Schuh 1978:280-283).

Neutralization to trill in preconsonantal position appears to necessitate reference to two distinct conditioning environments, namely before alveolar noncontinuants (e.g., \(s\theta[rt]u\) 'string beads', \(a[rd]\)\(aatu\) 'agree to, approve of', etc) and before lateral fricatives (e.g., \(ga[r]\)\(a\) 'strong in taste, bitter' and \(ngu[rl]\)\(adliya\) 'throat'). However, further consideration of the articulatory properties of lateral fricatives makes it possible to unify these two seemingly disparate segmental contexts. As Ladefoged and Maddieson (1996) argue,

"laterals are segments with two articulations. One governs the location and type of stricture of the central articulation and the other governs the location and size of the lateral aperture. [...] Lateral fricatives ... will normally be produced with a central closure since this will facilitate narrowing of the lateral escape aperture" (214).

If Ngizim lateral fricatives [\(l\)] and [\(\bar{l}\)] possess not only a lateral fricative release but also a central closure in the alveolar region, then the common property that they share with alveolar stops [t, d, \(\ddot{d}\), n] is the specification for alveolar closure. In other words, both sets of phones are specified as noncontinuant with respect to alveolar constriction, while the lateral fricatives are additionally specified for lateral fricative release.
Combining the insights of Padgett (1994, 1995) and Walsh (1997), Holt (in press) proposes a representation of liquids involving both primary and secondary Place nodes that dominate different stricture values.\(^7\) I adapt Holt's geometric representation of liquids as shown in (4.26), with aperture positions substituting for specifications of the feature [cont]. (N.B.: CPI and VPI denote Consonantal Place and Vocalic Place, respectively.)

\[(4.26) \quad \text{Feature-geometric representation of laterals as segments with dual aperture specifications (cf. Holt, in press)}\]

\[
\begin{array}{c}
\text{CPI} \\
\text{cor} \\
\text{VPI} \\
\text{A}_0 \\
\text{dor} \\
\text{A}_m
\end{array}
\]

If we assume that lateral fricatives are specified for A\(_f\) fricative aperture under the secondary dorsal node, then this representation captures the insight of Ladefoged and Maddieson (1996) regarding the dual articulatory nature of this type of segment:

---

\(^7\) See Holt's (2000) review of the longstanding debate regarding the continuancy specification of lateral liquids. In short, some researchers have argued that /l/ is [–cont], while others have made the opposite claim that /l/ is [+cont]. The geometry in (4.26) reflects Holt's proposed solution to the paradox, namely that /l/ is both continuant and noncontinuant, as evidenced by the presence of A\(_m\) and A\(_0\) positions, respectively.
The geometry of lateral fricatives shown in (4.27) illustrates the relatedness of these segments to alveolar noncontinuants: both are specified with $A_0$ closure under the coronal node. The true generalization regarding preconsonantal neutralization, then, is that Ngizim disallows the tap before any segment in which coronal directly dominates an $A_0$ aperture position, that is, before coronal (alveolar) noncontinuants.

4.4.2.2 Analysis

The constraint ranking required for Ngizim is essentially identical to that proposed for Kairiru in (4.23) above. The evaluation in tableau (4.24) is also equivalent in the case of Ngizim, except for the lack of postconsonantal clusters mentioned above.

Preconsonantal neutralization in Ngizim deserves further comment. In Section 3.3.3 of Chapter 3, I argued that rhotic + consonant sequences are not Place/stricture-sharing configurations, even when the second consonant is itself alveolar. This explains why the tap can appear before homorganic consonants in Iberian Romance, either

\[ CPI = [\tilde{h}, \tilde{\beta}] \]

\[ cor \ VPl \]

\[ A_0 \ dor \]

\[ A_f \]

\[ (4.27) \text{ Proposed aperture-theoretic representation of lateral fricatives}^{71} \]

---

\(^{71}\text{The voicing distinction between lateral fricatives is represented by specifications for the feature [voice], not shown in this representation.}\)
obligatorily as in European Portuguese or in stylistically-controlled variation with the trill as in Catalan and Spanish. The same explanation was proposed for Palauan [rs] clusters, shown in (4.18) above. In all cases, the rhotic and the following consonant each maintain separate Place nodes, thereby rendering *FAST/SAME SITE irrelevant in the evaluation.

In the case of Ngizim, we see once again that the independence of Place nodes allows the tap to surface before any consonant regardless of its place specification. As shown in (4.28), tap and trill are generally contrastive preconsonantally:

(4.28) Independence of Place allows preconsonantal contrast in Ngizim

a. \[ r^\text{v}s \neq rs \]
b. \[ r^\text{v}m \neq rm \]

As discussed above, however, the tap is disallowed before coronal noncontinuants. A possible analysis of this restriction is to posit that rhotics share coronal Place with a following consonant if the consonant is specified for [cor, A_0], that is, if the consonant involves complete closure in the alveolar region. A constraint-based formulation of this restriction is given in (4.29):

(4.29) Condition on the independence of coronal Place in rhotic + consonant clusters

\[
\text{RHOTIC CONDITION (abbreviated RHOCOND)}
\]

*[\rho] [cor cor]

\[ A_0 \]
The effect of this constraint on the geometry of rhotic + consonant clusters is illustrated in (4.30):

(4.30) Rhotics share coronal Place with following coronal noncontinuants (i.e., alveolar stops and lateral fricatives)

a. \([\text{rn}]\) cf. \(*[\text{r}^*\text{n}]\)  
   CPI  
   cor  
   A_tA_0  

b. \([\text{rH}]\) cf. \(*[\text{r}^*\text{l}]\)
   CPI  
   cor  
   VPl  
   A_tA_0  
   dor  
   A_f  

In (4.30a), RHOCOND favors a representation in which the rhotic and the following nasal share coronal Place. With respect to rhotics followed by lateral fricatives in (4.30b), the constraint is satisfied by the sharing of coronal under the CPI node, and the lateral fricative retains its secondary dorsal specification under VPl. In both cases, Place/stricture-sharing allows \(*\text{FAST/SAME SITE}\) to become active, thereby ensuring neutralization to trill.

Tableau (4.31) shows how RHOCOND and \(*\text{FAST/SAME SITE}\) work together to yield neutralization to trill before coronal noncontinuants in Ngizim. (N.B.: Recall that Place/stricture-sharing clusters are indicated by the use of \{\} brackets.)
Contrast preserved before coronal fricatives, but neutralization to trill before coronal noncontinuants in Ngizim

(4.31)  

<table>
<thead>
<tr>
<th></th>
<th>RHOCOND</th>
<th>*FAST/SAME</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>V_r^v{s} ≠ V_r{s}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>V_r^v{s}</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>V_r{s}</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>V_r^v{l} ≠ V_r{l}</td>
<td><em>!</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>V_r^v{l}</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>V_r{l}</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>g.</td>
<td>V{r^v{l}} ≠ V{r{l}}</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>V{r^v{l}}</td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>i.</td>
<td>V{r{l}}</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Since the clusters in candidates (a–c) are not Place-sharing, *FAST/SAME SITE is irrelevant. Therefore, lower-ranked CONTRAST(dur) preserves contrast between the tap and trill before alveolar fricatives. In each of the clusters in candidates (d–i), the rhotic appears before a lateral fricative. RHOCOND rules out candidates (d–f) because the rhotic has an independent Place node before a following coronal noncontinuant (see (4.30b) above). Of the remaining candidates, *FAST/SAME SITE rules out (g) and (h) because the tap appears in a Place/stricture-sharing configuration. The winner is (i) with neutralization to trill before the lateral fricative.

There are further issues to consider with respect to the cross-linguistic implications of positing a constraint such as RHOCOND in order to account for preconsonantal neutralization in Ngizim. Richard Page (personal communication) raises a question regarding the potential effects of RHOCOND in a language like Spanish, namely: Why does this constraint not force a trill realization preconsonantly in a word such as
‘Tuesday’, in which the rhotic appears before a following coronal stop? The reason it does not is because the post-rhotic consonant in this Spanish example is actually dental: [t]. As formulated in (4.29), RHOCOND requires that the consonant be homorganic with the preceding rhotic, i.e., that the overall cluster have an alveolar Place of articulation. On the assumption that dental plosives possess an intermediate [dental] feature between the primary coronal node and the terminal aperture positions, the representations in (4.32) show why RHOCOND is irrelevant in rhotic + dental clusters:

(4.32) RHOCOND forces Place/stricture-sharing before alveolar noncontinuants but not before dental noncontinuants

a. \[ [\text{rn}] \quad \text{cf. } *[r^\text{v}n] \]
   \[
   \begin{array}{c}
   \text{cor} \\
   \text{cor} \\
   A_tA_0 \\
   A_mA_tA_mA_0
   \end{array}
   \]

b. \[ [r^\text{v}t] \quad [r_t] \]
   \[
   \begin{array}{c}
   \text{cor} \\
   \text{cor} \\
   \text{dent} \\
   \text{cor} \\
   \text{cor} \\
   A_mA_tA_mA_0A_mA_tA_0A_m
   \end{array}
   \]

In (4.32a), RHOCOND is violated by Place independence when the alveolar rhotic appears before the alveolar \( A_0 \) nasal and, therefore, prefers that both segments share Place. In (4.32b), RHOCOND is irrelevant because the following consonant is dental, and the prediction is that both the tap and trill should be possible realizations, depending, of course, on the ranking of other constraints such as *FAST, *HOLD, and CONTRAST(dur).

Nevertheless, Spanish does possess consonants that are specified for \( A_0 \) alveolar closure after rhotics, namely [n] and [l] (see (4.26) above for the geometric representation of the latter). Left to its own devices, RHOCOND would force a Place/stricture-sharing configuration in these cases, thereby allowing *FAST/SAME SITE to decide in favor of
preconsonantal neutralization to trill. The resulting prediction is that only the trill should be possible in Spanish clusters of the form rhotic + [n] or [l], as is the case is Ngizim, e.g., *kurna* 'a thorny tree'. The fact remains, however, that in a word such as *carne* 'meat', Spanish exhibits stylistically-controlled variation between the tap and trill: [karne ~ karne] (cf. Table 4–3). Tableau (4.33) illustrates the problem:

(4.33) Obligatory neutralization to trill incorrectly predicted before alveolar nasal in Spanish

<table>
<thead>
<tr>
<th>Candidate</th>
<th>RHOCOND</th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vn ≠ Vrn</td>
<td><em>!</em></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Vn</td>
<td><em>!</em></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Vrn</td>
<td><em>!</em></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. V{rn} ≠ V{rn}</td>
<td><em>!</em></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. V{rn}</td>
<td><em>!</em></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. V{rn}</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RHOCOND rules out candidates (a–c) because the rhotic does not share Place with the following alveolar nasal. Among the remaining Place/stricture-sharing candidates, *FAST/SAME SITE decides in favor of (f), with neutralized trill, in a manner similar to Ngizim (4.31i).

---

72 As John Lipski (personal communication) suggests, however, further detailed empirical investigation may reveal that Ngizim-type realizations are, in fact, attested in one form or another. Along these lines, see Harris' (1985) analysis of Habanero Spanish, in which some liquid + coronal stop clusters are realized as uniform retroflected noncontinuant sequences.
Note that this problem remains unresolved even if \texttt{RHOCOND} is ranked low in the hierarchy, as shown in tableau (4.34):

\begin{center}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
 & *\textsc{Fast}/\textsc{Same} & *\textsc{Hold} & *\textsc{Fast} & \textsc{Contrast} (dur) & \textsc{RHOCOND} \\
\hline
a. \(Vr^\prime n \neq Vrn\) & * & *! & & ** & \\
\hline
b. \(Vr^\prime n\) & * & * & * & *! & \\
\hline
c. \(Vrn\) & * & * & * & * & \\
\hline
d. \(V\{r^\prime n\} \neq V\{rn\}\) & *! & * & * & * & \\
\hline
e. \(V\{r^\prime n\}\) & *! & * & * & * & \\
\hline
f. \(V\{rn\}\) & * & * & * & * & \\
\hline
\end{tabular}
\end{center}

*\textsc{Fast}/\textsc{Same} site rules out candidates (d) and (e), while lower-ranked *\textsc{Hold} and *\textsc{Fast} collectively disfavor candidate (a). The remaining candidates (b), (c) and (f) are equally harmonic until lowest-ranked \textsc{RHOCOND} has its say in the evaluation. Specifically, (b) and (c) violate this constraint because the rhotic does not share Place with the following alveolar nasal, just as in tableau (4.33) above for Ngizim. The problem is that \textsc{RHOCOND}, regardless of its ranking with respect to the constraints at hand, will always favor Place/stricture-sharing configurations in rhotic + alveolar nasal clusters, thereby allowing *\textsc{Fast}/\textsc{Same} site to force neutralization to trill.

As established in the discussion thus far, the \textsc{RHOCOND} constraint is clearly violated by certain clusters in languages such as Spanish. Throughout this dissertation, we have made the assumption that rhotic + consonant clusters do not constitute Place/stricture-sharing configurations in order to account for the fact that the tap can
occur before homorganic consonants.\textsuperscript{73} Such an implicit assumption is insufficient, however, if the problem illustrated by tableaux (4.33) and (4.34) is to be solved in any formal way. Therefore, let us formalize this assumption in terms of the constraint in (4.35):

\begin{equation}
\text{(4.35) Rhotic Place (abbreviated as RHOPL)}
\end{equation}

\begin{itemize}
\item Given a cluster of the form rhotic + consonant, the rhotic maintains Place independently of the following consonant.
\end{itemize}

This constraint has a plausible phonetic basis in the perceptibility of tap and trill segments. The $A_mA_tA_m$ contour representation (see Section 3.2.2.1 of Chapter 3) provides the tap with a release position, which functions to ensure perceptibility of the tap in preconsonantal position. Similarly, the $A_t$ trill possess an inherently salient acoustic structure, consisting of vocalic formant values briefly interrupted by periods of stop-like silence (see Section 3.1.2.1 of Chapter 3). RHOPL, then, is grounded in the greater perceptibility of preconsonantal tap and trill vis-à-vis other segment types, as ensured by their articulatory and acoustic properties (cf. unreleased plosives and nasals, which are represented simply as $A_0$ closure positions).

The ranking of RHOCOND with respect to RHOPL accounts for the different behavior of preconsonantal rhotics in Spanish and Ngizim. Specifically, the ranking of RHOPL $\gg$ RHOCOND dictates that Spanish rhotic + consonant clusters are not Place/stricture-sharing, as shown in tableau (4.36):

\begin{itemize}
\item \textsuperscript{73} This assumption was initially stated in Section 3.3.3 of Chapter 3.
\end{itemize}
Stylistically-controlled variation between tap and trill before alveolar nasal in Spanish

<table>
<thead>
<tr>
<th></th>
<th>RHOPl</th>
<th>RHOCOND</th>
<th>*Fast/Same</th>
<th>*Hold</th>
<th>*Fast</th>
<th>Contrast (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vt'n ≠ Vrn</td>
<td></td>
<td><strong>!</strong></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. Vt'n</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. Vrn</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d. V{r'n} ≠ V{rn}</td>
<td></td>
<td><em>!</em></td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e. V{r'n}</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f. V{rn}</td>
<td></td>
<td>*!</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

High-ranking RHOPl rules out Place/stricture-sharing candidates (d–f). The double violation of RHOCOND by the Place-independent candidate (a) eliminates this candidate from the evaluation. The remaining candidates (b) and (c) share the same number of constraint violations and are thus equally harmonic. The result is that both the tap and trill may appear in stylistically-controlled variation before alveolar nasals in Spanish.

The opposite ranking of RHOCOND » RHOPl in Ngizim still guarantees the desired outcome of neutralization to trill, as shown in tableau (4.37):

---

74 The ranking of RHOPl » RHOCOND may be assumed for Catalan and those dialects of European Portuguese with alveolar trills, since the tap surfaces before alveolar A₀ segments in these varieties as well.
Neutralization to trill before alveolar nasal in Ngizim

<table>
<thead>
<tr>
<th></th>
<th>RHOCOND</th>
<th>RHOPL</th>
<th>*FAST/SAME</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vtvn ≠ Vrn</td>
<td>*! *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Vtvn</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Vrn</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. V{r^v}n ≠ V{rn}</td>
<td>**!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. V{r^v}n</td>
<td>*</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. V{rn}</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Candidates (a–c) are ruled out by high-ranking RHOCOND because the rhotic does not share Place with the following alveolar nasal. Candidate (f) with preconsonantal trill fares better than its competitors (d) and (e) with respect to the lower-ranked constraints RHOPL and *FAST/SAME. As encapsulated by the ranking of RHOCOND » RHOPL, the general independence of preconsonantal rhotic Place in Ngizim is sacrificed in order to satisfy the restriction that a rhotic + alveolar noncontinuant cluster must not maintain distinct Place nodes.

4.4.3 Kurdish

A member of the Indo-Iranian group of the Indo-European language family, Kurdish is spoken in Kurdistan and parts of Iran, Iraq and Turkey. With respect to the distribution of the alveolar tap and trill in Kurdish, Abdulla and McCarus (1967) observe that "only the trill occurs at the beginning of a word… Any place else in the word either variety of r may occur" (9). The complete distribution is shown in Table 4–10:
Table 4–10: Rhotic distribution in Kurdish (Abdulla and McCarus [AM] 1967; McCarus [M] 1997)

<table>
<thead>
<tr>
<th>Position</th>
<th>Realization</th>
<th>Examples</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervocalic</td>
<td>contrast</td>
<td>[bɔɾə] 'take some!'</td>
<td>AM: p. 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[bɔɾə] 'release it!'</td>
<td></td>
</tr>
<tr>
<td>Word-initial</td>
<td>trill</td>
<td>[ɾoʃ] 'sun'</td>
<td>M: pp. 693, 704</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ɾoʃekiwa] 'a day like this'</td>
<td></td>
</tr>
<tr>
<td>After consonant</td>
<td>contrast</td>
<td>[brin] 'wound'</td>
<td>AM: p. 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[brin] 'to cut'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[xɾap] 'bad'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[ʔəkrə] 'he buys'</td>
<td></td>
</tr>
<tr>
<td>Before consonant</td>
<td>contrast</td>
<td>[brımə] (a kind of pastry)</td>
<td>AM: p. 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[pɜɾmə] 'fluttering of the lips'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[wɨɾŋ] 'stomach, belly'</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>[wɨɾk] 'temper tantrum'</td>
<td></td>
</tr>
<tr>
<td>Word-final</td>
<td></td>
<td>[piɾ] 'old'</td>
<td>AM: p. 10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[piɾ] 'full'</td>
<td></td>
</tr>
</tbody>
</table>

4.4.3.1 Observations

With respect to intervocalic and word-initial positions, the Kurdish tap and trill pattern in a manner similar to Iberian Romance languages and Basque. These languages allow contrast between vowels word-medially, but the contrast is neutralized to trill word-initially. However, the parallel does not hold in other positions within the word. Kurdish maintains tap/trill contrast not only intervocally but also in heterorganic clusters and word-finally. Contrast is neutralized in these positions in Iberian Romance and Basque.
Finally, since Abdulla and McCarus (1967) do not explicitly mention homorganic clusters containing a rhotic, I assume such sequences to be unattested.

### 4.4.3.2 Analysis

The parallel between Iberian Romance, Basque, and Kurdish stems from the fact that in these languages, (1) \( \text{CONTRAST(dur/V\_V)} \) dominates \( \text{*HOLD and *FAST} \), ensuring intervocalic contrast, and (2) \( \text{*FAST/INITIAL} \) dominates \( \text{CONTRAST(dur/#\_V)} \) and \( \text{*HOLD} \), ensuring word-initial neutralization to trill. Kurdish differs from the other languages in the ranking of \( \text{CONTRAST(dur)} \) with respect to \( \text{*HOLD and *FAST} \), which ensures contrast maintenance in heterorganic clusters and word-finally. The complete ranking for Kurdish is shown in (4.38), and tableau (4.39) below illustrates the evaluation of candidates:

(4.38)  Constraint ranking for Kurdish

\[
\text{CONTRAST(dur/V\_V),} \\
\text{\hspace{1cm} \text{*FAST/INITIAL}} \\
\text{\hspace{1.5cm} \text{CONTRAST(dur/#\_V),}} \\
\text{\hspace{2.5cm} \text{*FAST/SAME}} \\
\text{\hspace{3.5cm} \text{CONTRAST(dur)}} \\
\text{\hspace{4.5cm} \text{*HOLD,}} \\
\text{\hspace{4.5cm} \text{*FAST}}
\]
(4.39) Contrast intervocally and elsewhere, except neutralization to trill word-initially in Kurdish

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST (dur/V_V)</th>
<th>*FAST/INITIAL</th>
<th>CONTRAST (dur/#_V)</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>VrV ≠ VrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b</td>
<td>VrV</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c</td>
<td>VrV</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>d</td>
<td>#rV ≠ #rV</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e</td>
<td>#rV</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>f</td>
<td>rV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>g</td>
<td>C rV ≠ CrV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>h</td>
<td>C rV</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i</td>
<td>CrV</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>j</td>
<td>VrC ≠ VrC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>k</td>
<td>VrC</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l</td>
<td>VrC</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>m</td>
<td>Vr# ≠ Vr#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>n</td>
<td>Vr#</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>Vr#</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Except for the obligatory word-initial trill shown in candidate (f), Kurdish rhotics are contrastive in all positions: intervocally (a), in heterorganic clusters (g,j), and word-finally (m).

4.4.3.3 Word-initial Neutralization and Harmonic Incompleteness

Of all the languages appearing in the typological survey of this chapter, Kurdish is unique in that it appears to contravene the implicational relation among positions of contrast, which I repeat below from (4.1):
(4.40) Position 1 < Position 2 < Position 3
Intervocalic Word-initial Heterorganic clusters, Word-final

where contrast in Position x entails contrast in Position y iff y < x.

If the tap and trill are phonologically contrastive in a given position within the hierarchy in (4.40), then they are also contrastive in all positions to the left. As shown by the data in Table 4–10, however, Kurdish allows the contrast intervocalically, in heterorganic clusters, and word-finally, but neutralizes the contrast to trill word-initially. According to (4.40), we should expect contrast word-initially as well as intervocalically, since contrast is preserved elsewhere.

According to Prince and Smolensky (1993), "harmonic completeness means that when a language admits forms that are marked along some dimension, it will also admit all the forms that are less marked along that dimension" (185). Under the proposed system, the positional hierarchy in (4.40) is the relevant dimension. The hierarchy is in itself harmonically complete because rhotic duration contrast in more marked positions (e.g., in heterorganic clusters and word-finally) entails contrast in all less marked positions (e.g., word-initially and between vowels). However, the fact that the positional hierarchy is harmonically complete does not mean that harmonically incomplete languages are impossible. A language is harmonically incomplete if it admits a form that is marked along some dimension without admitting less marked structures as well. As Morelli (1999) argues,

"[o]ther factors may, indeed, come into play that give rise to harmonically incomplete languages. In this type of language a more marked structure surfaces because of the constraint system, but a less marked structure cannot surface due to some other constraint that interacts with the system
proposed. In particular an harmonically incomplete language may result from the interaction of various dimensions of markedness\textsuperscript{6} (53).

In short, we should expect to find instances of harmonic incompleteness with respect to a given markedness dimension since other markedness dimensions may also come into play.

The notion of harmonic incompleteness provides a context within which to view Kurdish word-initial neutralization. Like Kairiru and Ngizim, Kurdish allows rhotic duration contrast in marked positions (i.e., in heterorganic clusters and word-finally) because $\text{CONTRAST}(\text{dur})$ dominates $\text{*HOLD}$ and $\text{*FAST}$, as shown in (4.38). Recall that $\text{*FAST/INITIAL}$ is a separate, positional variant of $\text{*FAST}$ which also interacts with the $\text{CONTRAST}(\text{dur})$ hierarchy. Since $\text{*FAST/INITIAL}$ dominates $\text{CONTRAST}(\text{dur/#_V})$, contrast is not possible in the less marked word-initial position. Therefore, Kurdish is harmonically incomplete with respect to the positional hierarchy in (4.40) due to the markedness of word-initial tap, as ensured by $\text{*FAST/INITIAL}$. However, the $\text{CONTRAST}(\text{dur})$ constraint hierarchy in itself is harmonically complete and fully capable of accounting for the implicational relation among contrastive positions observed in other languages of the typology.

### 4.5 Comparison with Syllable-based Alternatives

In Section 2.3 of Chapter 2, it was shown that not all aspects of the typological behavior of the tap and trill can be adequately captured with reference to syllable structure alone. Specific arguments are repeated below for convenience:
1. The surface trill is ambiguous, patterning as a single phonological unit in some languages (e.g., Ngizim, Kaliai-Kove, and Kairiru), and as a cluster in others (e.g., Palauan and Kurdish). It is, therefore, not always feasible to represent the tap/trill contrast in terms of a singleton-geminate pair. However, some account must be given of the fact that the trill can surface as the phonetic reflex of an underlying cluster of taps.

2. In Basque and Kaliai-Kove, neutralized trills behaves in a manner not predicted by sonority principles, surfacing to the exclusion of taps in complex onsets and syllable rhymes.

3. In Kairiru and Ngizim, obligatory neutralization to trill is conditioned not by syllable position but by the Place/stricture-sharing configuration of the cluster.

I postpone discussion of the ambiguous nature of surface trill until Chapter 5, which concludes the dissertation with a focus on representational issues.

The remainder of this chapter focuses on the second and third arguments above. In both cases, I show how the phonetically-based OT analysis illustrated in this chapter effectively avoids the problems facing syllable-based alternatives of the same phenomena.

4.5.1 Sonority and Neutralization to Trill in Basque and Kaliai-Kove

Recall the prediction of sonority-based accounts that if the trill occurs as the second member of a complex onset or in rhyme position, then the tap should also be allowed to occur in these same positions. This is demonstrated by the tableaux in (4.41), where
SONORITY is a constraint which bans the less sonorous trill from complex onsets and rhyme position. (N.B.: Syllable boundaries are represented with [ ] brackets.)

(4.41)  Trill in complex onset and syllable rhyme entails tap in the same positions

<table>
<thead>
<tr>
<th></th>
<th>SONORITY</th>
<th>CONTRAST(dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. [CrV ≠ [CrV]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b. [CrV]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. [CrV]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>d. [CrV] ≠ [CrV]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>e. [CrV]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. [CrV]</td>
<td>*!</td>
<td>*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CONTRAST(dur)</th>
<th>SONORITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>g. [CrV ≠ [CrV]</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>h. [CrV]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>i. [CrV]</td>
<td>*!</td>
<td>*</td>
</tr>
<tr>
<td>j. [CrV] ≠ [CrV]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>k. [CrV]</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>l. [CrV]</td>
<td>*!</td>
<td>*</td>
</tr>
</tbody>
</table>

If SONORITY ranks above CONTRAST(dur), then only the tap is allowed, as shown in candidates (b,e). If SONORITY ranks below CONTRAST(dur), then both the trill and tap occur contrastively, as seen in (g,j). No ranking of these two constraints will allow the trill to surface in onset clusters or syllable rhymes without also allowing tap to surface in the same positions.

The prediction of sonority-based accounts is falsified by the behavior of rhotics in Basque and Kaliai-Kove. In both languages, the trill surfaces to the exclusion of the tap in onset clusters and in rhyme position, as shown in (4.42) and (4.43):
(4.42) Basque trill in onset clusters and in rhyme position (see Table 4–4)

a. \[\text{[pr]antziar}\] 'French'
\[\text{an[dr]e}\] 'woman'

b. \[\text{a[r.t]o}\] 'corn'
\[\text{no[rk]}\] 'who–ERG'
\[\text{enbo[r]}\] 'trunk'

(4.43) Kaliai-Kove trill in onset clusters and in rhyme position (see Table 4–6)

a. \[\text{[yrem]}\] 'somewhat, slightly'
\[\text{[mo.krup]}\] 'frog'

b. \[\text{[m^hbar.ku]}\] 'spirit mask type'
\[\text{[na.par]}\] 'dog's tooth net bag'
\[\text{[t^h^a.^b^u^r]}\] 'trumpet'

These data are not problematic for the phonetically-based OT account, as demonstrated earlier in this chapter. In the positions shown above, the tap and trill are governed by two independent and context-free markedness constraints, *FAST and *HOLD, respectively. When *FAST dominates CONTRAST(dur) and *HOLD, the result is that the trill is optimal in heterorganic clusters and word-finally, as shown in tableau (4.44):
Neutralization to trill in heterorganic clusters and word-finally

<table>
<thead>
<tr>
<th></th>
<th>*Fast</th>
<th>CONTRAST(dur)</th>
<th>*Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>f.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td></td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

As thoroughly demonstrated throughout this chapter, the CONTRAST(dur), *Fast, and *Hold constraints may be ranked in different ways, yielding different predicted grammars. The particular ranking of constraints in tableau (4.44) is an expected possibility, which is empirically validated by the behavior of rhotics in Basque and Kaliai-Kove. In contrast, this behavior is completely unexpected on the sonority-based account shown in (4.41).

4.5.2 Syllable Position and Neutralization to Trill in Kairiru and Ngizim

The neutralization of postconsonantal rhotics to trill in Iberian Romance has been analyzed in previous syllable-based accounts as being dependent upon the heterosyllabic status of the consonant + rhotic cluster. Consider the strengthening rule in (4.45), which Harris (1983) posits to account for the data in (4.46):
276

(4.45) Underlying tap strengthens to trill after heterosyllabic consonants (Harris 1983)

\[ r \rightarrow r / [+\text{cons}] \_ \]

Rhyme

(4.46) Trill is obligatory in syllable-initial postconsonantal position in Spanish

\begin{tabular}{lll}
  [on.ra] & \textit{honra} & 'honor' \\
  [al.re.dor] & \textit{alrededor} & 'around' \\
  [iz.ra.el] & \textit{Israel} & 'Israel' \\
\end{tabular}

The consonant + rhotic clusters in (4.46) are all Place-sharing, but the rule in (4.45) treats this as incidental and irrelevant to the strengthening process. Rather, syllable position—more specifically, \textit{heterosyllabic}—is what conditions neutralization to trill in postconsonantal contexts.

In this chapter, Kairiru and Ngizim were shown to exhibit neutralization to trill in certain consonant-adjacent positions. For instance, only the trill surfaces after homorganic consonants in Kairiru, while the tap and trill are contrastive after heterorganic ones, as seen in (4.47):
Neutralization to trill after tautosyllabic homorganic consonants, but contrast after tautosyllabic heterorganic consonants in Kairiru (see Table 4–8)

a. After homorganic consonants
   
   [al.sru]  'he chops them down'
   [sru]    'pair, brace'
   [wun.tru]  'I close the door'

b. After heterorganic consonants
   
   [a.pri.ma.ru]  'he persuades them'
   [for.pru]     'spotted snake eel'
   [a.qrei]      'it is raining'
   [qra.p'am]    'your shoulder'

In Ngizim, only the trill surfaces before consonants specified as [cor, A₀], as in (4.48), while the tap and trill are contrastive before all other consonants, as in (4.49):

(4.48)  Ngizim trill before coronal stops and lateral fricatives (see Table 4–9)

   sə[r.t]u  'string beads'
   a[r.d]aatu  'agree to, approve of'
   ga[r.d]u  'cut notch in'
   ku[r.n]a  'a thorny tree'
   ga[r.l]a  'strong in taste, bitter'
   ngu[r.l]adliya  'throat'
(4.49) Ngizim tap/trill contrast before other consonants (see Table 4–9)

a. Before labials
   *ka*[r.m]u 'cut down'
   *ka*[r.m]ai 'chieftainship'

b. Before alveolar fricatives
   *ku*[r.s]aasiya 'kidney'
   *bo*[r.z]anzan 'rolling around on the ground'

c. Before palatals
   *aats*[r.s]an 'perfume'
   *pɔ*[r.s]i 'lip'

d. Before velars
   *tɔ*[r.k]u 'orphan'
   *tɔ*[r.k]akdu 'repeatedly press on'

In both languages, *homorganicity*—more specifically, Place/stricture-sharing—is the driving force behind neutralization to trill, not syllable position. Since Harris (1983), postconsonantal strengthening in Iberian Romance has been argued to depend on syllable structure. As the above data show, neutralization to trill in Kairiru and Ngizim is not dependent on the syllable position of the rhotic. Neutralized trills occupy the same syllable position as their contrastive counterparts, namely C₂ of complex onsets in Kairiru and coda position in Ngizim.

The phonetically-based OT analysis developed in this dissertation provides a unified account of neutralization to trill in Iberian Romance, Kairiru, and Ngizim. By adopting the Segmental Autonomy hypothesis of Steriade (1999a, 2001a), the analysis formulates phonotactic restrictions on rhotics in strictly linear terms without reference to syllable boundaries. The relevant constraint in this case is *FAST/SAME SITE, which I repeat below from Chapter 3:
Avoid faster-than-usual articulatory transitions in Place-sharing clusters involving the tongue tip.

The Spanish clusters in (4.46), the Kairiru clusters in (4.47a), and the Ngizim clusters in (4.48) all constitute instances of Place/stricture-sharing. Under such configurations, neutralization to trill is enforced by the *FAST/SAME SITE constraint, which dominates the context-free *HOLD and CONTRAST(dur) constraints in all three languages (and, by hypothesis, in all languages of the rhotic duration hierarchy).

The tableaux in (4.51) through (4.53) illustrate how *FAST/SAME SITE ensures trills in Place/stricture-sharing clusters, while lower-ranked constraints determine the outcome in clusters that do not share Place/stricture:

(4.50)  *FAST/SAME SITE
Avoid faster-than-usual articulatory transitions in Place-sharing clusters involving the tongue tip

The Spanish clusters in (4.46), the Kairiru clusters in (4.47a), and the Ngizim clusters in (4.48) all constitute instances of Place/stricture-sharing. Under such configurations, neutralization to trill is enforced by the *FAST/SAME SITE constraint, which dominates the context-free *HOLD and CONTRAST(dur) constraints in all three languages (and, by hypothesis, in all languages of the rhotic duration hierarchy).

The tableaux in (4.51) through (4.53) illustrate how *FAST/SAME SITE ensures trills in Place/stricture-sharing clusters, while lower-ranked constraints determine the outcome in clusters that do not share Place/stricture:

(4.51)  Neutralization to tap after heterorganic consonants, but to trill in Place/stricture-sharing consonant + rhotic clusters in Spanish

<table>
<thead>
<tr>
<th></th>
<th>*FAST/SAME</th>
<th>*HOLD</th>
<th>*FAST</th>
<th>CONTRAST (dur)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. C'\text{r}V \neq \text{Cr}V</td>
<td>**!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b. C'\text{r}V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. \text{Cr}V</td>
<td>**!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>d. {C'\text{r}}V \neq {\text{Cr}}V</td>
<td>*!</td>
<td>**</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>e. {C'\text{r}}V</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>f. {\text{Cr}}V</td>
<td>**</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Recall our general assumption that rhotic + consonant sequences are not Place/stricture-sharing configurations, which explains why tap can appear before alveolar consonants in Iberian Romance (see Section 3.3.3 of Chapter 3) and before alveolar continuants in Palauan (see Section 4.3.2.1) and Ngizim (see Section 4.4.2.2). In order to account for obligatory trill before alveolar noncontinuants in Ngizim, an additional constraint, RHOCOND, was proposed in (4.29) to ensure Place merger in this position.
(4.52) Tap/trill contrast after heterorganic consonants, but neutralization to trill in Place/stricture-sharing consonant + rhotic clusters in Kairiru

<table>
<thead>
<tr>
<th></th>
<th>*FAST/SAME</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>C’rV ≠ CrV</td>
<td></td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>C’rV</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>CrV</td>
<td>*!</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>{C’r}V ≠ {Cr}V</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e.</td>
<td>{C’r}V</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>{Cr}V</td>
<td></td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>

(4.53) Tap/trill contrast before heterorganic consonants, but neutralization to trill in Place/stricture-sharing rhotic + consonant clusters in Ngizim

<table>
<thead>
<tr>
<th></th>
<th>*FAST/SAME</th>
<th>CONTRAST (dur)</th>
<th>*HOLD</th>
<th>*FAST</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Vr’C ≠ VrC</td>
<td></td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Vr’C</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>VrC</td>
<td>*!</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>V{r’C} ≠ V{rC}</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>e.</td>
<td>V{r’C}</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>V{rC}</td>
<td></td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>

To sum up, the obligatory neutralization of trill in certain clusters in Iberian Romance, Kairiru, and Ngizim is accounted for by one and the same formal mechanism, namely *FAST/SAME SITE. The success of the analysis stems from the fact that this phonotactic constraint makes reference not to syllable position but to the segmental context in which rhotics appear, in accordance with Segmental Autonomy.
4.5.3 Summary

As a phonological constituent, the syllable has played a central role in contemporary phonological theory. This is perhaps nowhere more evident than in the syllable-based accounts of Spanish rhotics reviewed in Chapter 2. However, there are cases in which syllable-based phonotactic statements make the wrong empirical predictions. Steriade (1997, 1999a, 2001a) argues that this is true with respect to patterns of voicing neutralization, aspiration, and place assimilation (see Section 1.2.3.1 of Chapter 1 on voicing neutralization). In this section, we have seen that this is true also with respect to the neutralization of rhotic duration contrast. In Basque, Kaliai-Kove, Kairiru, and Ngizim, the tap and trill pattern in ways that reference to syllable structure alone cannot capture. These patterns are easily accounted for by the phonetically-based OT analysis, which lends further support to Steriade's (1999a, 2001a) hypothesis regarding Segmental Autonomy. In short, phonotactic restrictions on the distribution of rhotics must be formulated in strictly linear terms without reference to syllable boundaries.
Chapter 5
Representational Issues and General Conclusions

As we saw in Chapter 2, previous accounts of Spanish rhotics have attempted to capture the durational contrast between the tap and trill through a number of phonological representations. These representations may be categorized into three main types, as shown in (5.1):

(5.1) a. Trill as a cluster of taps (Harris 1983)
\[
\begin{array}{c}
\text{C} \\
\text{r}
\end{array} \neq \begin{array}{c}
\text{C} \\
\text{r} \\
\text{r}
\end{array}
\]

b. Trill as a dually-linked geminate tap (Lipski 1990; Núñez Cedeño 1988, 1994)
\[
\begin{array}{c}
\text{C} \\
\text{r}
\end{array} \neq \begin{array}{c}
\text{C} \\
\text{r}
\end{array}
\]

c. Trill as a single phonological unit (Bakovic 1994; Bonet and Mascaró 1997; Morales-Front 1994)
\[
\begin{array}{c}
\text{C} \\
\text{r}
\end{array} \neq \begin{array}{c}
\text{C} \\
\text{r}
\end{array}
\]

The phonetically-based OT analysis developed in Chapter 3 falls into the third category. Rhotic duration is treated as a segmental property encoded by the aperture representations in (5.2):
This chapter focuses on issues of phonological representation, in particular the ambiguous nature of the trill. In some languages, the surface trill patterns as a single phonological unit but as a cluster in others. While it is not always feasible to represent the tap/trill contrast in terms of a singleton-geminate distinction, some account must still be given of the fact that the trill can surface as the phonetic reflex of an underlying cluster of taps. The goal of this chapter is to show how the ambiguous nature of the trill is accounted for in the phonetically-based OT analysis. We begin with a review of the evidence presented in Section 2.3 of Chapter 2.

5.1 Trill as A Single Phonological Unit

Evidence from Ngizim, Kaliai-Kove, and Kairiru suggests that a phonetic trill cannot always be interpreted as an underlying cluster of taps in (5.1a) or a phonological geminate tap that is dually linked to the timing tier in (5.1b). I briefly examine these arguments below.
5.1.1 Vowel Length Restrictions in Ngizim

Schuh (1981) observes that modulo a few rare exceptions, long vowels do not occur in closed syllables in Ngizim. Now, consider the data in (5.3) below, in which the trill surfaces after long vowels.

(5.3) Trill after long vowels in Ngizim (Schuh 1981)

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>jiːre</td>
<td>jiːʁe</td>
<td>'truth'</td>
</tr>
<tr>
<td>maːgiːra</td>
<td>maagiiʁa</td>
<td>'leader of the women in a town'</td>
</tr>
<tr>
<td>nasarə</td>
<td>nasaaʁa</td>
<td>'European'</td>
</tr>
<tr>
<td>saːru</td>
<td>saaʁu</td>
<td>'peer'</td>
</tr>
</tbody>
</table>

If the trill is a cluster of taps in (5.1a) or a dually-linked geminate tap in (5.1b), then the first C would be syllabified as the coda of the preceding syllable, which would violate the restriction against long vowels in closed syllables. If the dually-linked geminate tap is tautosyllabic, then it would constitute a onset cluster, thereby violating a restriction against complex syllable margins (Schuh 1978:279). These problematic representations are shown in (5.4):
(5.4)  a. Trill as heterosyllabic cluster of taps

* \( \sigma \sigma \) violates restriction against long vowels in closed syllables

\[ \text{C V V C C V} \]

s a r r u

b. Trill as heterosyllabic dually-linked geminate tap

* \( \sigma \sigma \) violates restriction against long vowels in closed syllables

\[ \text{C V V C C V} \]

s a r u

c. Trill as tautosyllabic dually-linked geminate tap

* \( \sigma \sigma \) violates restriction against complex syllable margins

\[ \text{C V V C C V} \]

s a r u

Since long vowels do not occur in closed syllables and complex onsets are disallowed, the fact that the trill surfaces after long vowels suggests that it is neither a cluster nor a dually-linked geminate.

5.1.2 Reduplication and Consonant Clusters in Kaliai-Kove

Kaliai-Kove reduplication involves copying the first CVC string of the base word, as illustrated in (5.5):
(5.5) Reduplication in Kaliai-Kove

a. \(\text{RED + } C_1VC_2V \rightarrow C_1VC_2C_1VC_2V\)

b. \(/\beta\text{ole}/\) \\
\(\text{RED + } \beta\text{ole} \rightarrow [\beta\text{ol}\beta\text{ole}]\) 'boar's tusks'

Evidence that the trill is not a cluster or dually-linked geminate comes from the fact that an entire trill reduplicates as a single segment in the coda of the copied CVC syllable, as shown in (5.6a). If the trill were an underlying (heterosyllabic or tautosyllabic) sequence of taps, only the first tap would reduplicate, as in (5.6b):

(5.6) a. Trill as single phonological unit \\
\(/\text{i\text{are}}/\) 'he copulates' \\
\(/\text{i} + \text{RED + } \text{gare}\) \(\rightarrow [\text{i\text{aryare}}]\) 'he copulates (durative)'

b. Trill as heterosyllabic geminate tap \\
\(/\text{i} + \text{RED + } \text{garre}\) \(\rightarrow *[\text{i\text{aryare}}]\)

Furthermore, among the consonant clusters not created by reduplication are three which contain a consonant and a trill, as shown in (5.7):

(5.7) Kaliai-Kove trill in clusters

a. \([\text{yrem}]\) 'somewhat, slightly' \\
\([\text{mokrup}]\) 'frog'

b. \([\text{m}b\text{arku}]\) 'spirit mask type'

If the trill is a cluster or dually-linked geminate, then these would be three-consonant clusters (e.g., \(/\text{yrr}/, /\text{krr}/, /\text{rrk}/\), which do not otherwise occur in Kaliai-Kove.
5.1.3 Syllable Structure in Kairiru

Wivell (1981) argues that the syllable structure templates of Kairiru are as follows:

(5.8) Syllable structure templates for Kairiru

a. (C) (C) V (V) (C) (G)

b. CVVV

As made clear in (5.8), onset clusters are limited to no more than two consonants, while coda clusters are disallowed. In addition, Wivell notes that the only possible onset clusters are of the form stop + liquid and fricative + non-fricative. While most consonants may combine across syllable boundaries, no geminate clusters have been observed in Kairiru.

Evidence that the trill is a phonological singleton comes from the fact that tap and trill are contrastive in complex onsets and in coda position, as shown by the examples in (5.9):

(5.9) Kairiru tap/trill contrast in complex onsets and in coda position

a. [a.pri.ma.ru] 'he persuades them' [for.pru] 'spotted snake eel'
   [a,qrei] 'it is raining' [qra,p^am] 'your shoulder'

b. [pur] 'pig' [nar] 'pebble'
   [wur] 'crayfish' [wur] 'banana'

The postconsonantal trills in (5.9a) cannot be clusters or dually-linked geminates because the complex onsets would consist of three consonants, thereby contravening (5.8a).
Similarly, the final trills in (5.9b) must be single units because coda clusters are not allowed.

5.2 Trill as A Phonological Geminate Tap

The cases examined above indicate that surface trill acts as a single phonological unit. However, evidence pointing in the opposite direction comes from Palauan and Kurdish in which the trill surfaces as the phonetic reflex of a morphologically derived sequence of taps. This motivates the representation of the trill as a cluster in (5.1a) or a dually-linked geminate tap in (5.1b).

5.2.1 Liquid Assimilation in Palauan

Palauan exhibits a process of liquid assimilation in which a lateral assimilates either to an adjacent rhotic or to a nearby rhotic across an intervening vowel. This process is prevalent in verbal morphology. For example, Josephs (1975) shows how the final /l/ of the verb stem /dul/ 'to burn, barbeque' assimilates to the /r/ of the third person singular object pronoun suffix /ur/ in the present perfective form:
(5.10) Liquid assimilation across vowels in Palauan (Josephs 1975:165–166)

\[ /mə + d + ul + ūr/ \] (basic form: verb marker + verb stem + object pronoun)

\[ d + mə + ul + ūr \] (by metathesis)
\[ d + m + ul + ūr \] (by deletion of \( m \))
\[ d + u + ul + ūr \] (by change of verb marker to \( u \) in unstressed syllable)
\[ d + ul + ūr \] (by deletion of verb marker)
\[ d + ur + ūr \] (by assimilation of \( l \) to \( r \))

\[ [duru\ ū]\] 'burn/barbeque it'

In the last step of the derivation, regressive assimilation changes the final lateral of the verb stem to a tap, thereby yielding the phonetic form \([duru\ ū]\).

One case in which liquid assimilation yields a cluster of taps is in the derivation of the past perfective form of the verb shown in (5.10) above:

(5.11) Liquid assimilation yields a cluster of taps in Palauan (Josephs 1975:166)

\[ /mə + d + il + ul + ūr/ \] (basic form, including infixed past tense marker \( –il \))

\[ d + mə + il + ul + ūr \] (by metathesis)
\[ d + m + il + ul + ūr \] (by deletion of \( m \))
\[ d + u + il + ul + ūr \] (by change of verb marker to \( u \) in unstressed syllable)
\[ d + il + ul + ūr \] (by deletion of verb marker)
\[ d + il + l + ūr \] (by deletion of unstressed \( u \))
\[ d + il + r + ūr \] (by assimilation of \( l \) to \( r \))
\[ d + ir + r + ūr \] (by assimilation of \( l \) to \( r \))

\[ [diru\ ū]\] 'burned/barbequed it'

In the last step of the derivation, regressive assimilation changes the final lateral of the past tense infix to tap, thereby producing a cluster with the final tap of the verb stem.

This cluster is realized as a single trill in the phonetic representation. Josephs' account of
past tense infixation in (5.11) shows that some Palauan trills result from morphologically derived tap clusters.

5.2.2 Passive Affixation in Kurdish

In Kurdish, affixation of the passive tap morpheme to a tap-final verb stem results in a derived surface trill:

(5.12) Affixation of passive tap /t/ in Kurdish (Abdulla and McCarus 1967)

<table>
<thead>
<tr>
<th>Active form</th>
<th>Passive form</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ʔəzaɾe</td>
<td>ʔəzaɾə 'he is known'</td>
</tr>
<tr>
<td>b. ʔəɾəɾə</td>
<td>ʔəɾəɾə 'he is sent'</td>
</tr>
</tbody>
</table>

As shown in (5.12b), two taps that come to be adjacent in the derivation are realized as a single surface trill. This suggests that the Kurdish trill is sometimes a morphologically derived cluster of taps, similar to the Palauan trill.

5.3 Analysis of The Ambiguous Nature of Surface Trill

The behavior of the trill in Ngizim, Kaliai-Kove, and Kairiru discussed in Section 5.1 poses no problem for the phonetically-based OT analysis developed in this dissertation, which posits that tap and trill are both single phonological units differentiated by aperture structure (see (5.2) above). If the trill is a single phonological unit, then the prediction is
that it should be able to appear after long vowels. This is exactly the case in Ngizim, where tap and trill contrast intervocally after a long vowel:

(5.13) Tap and trill are contrastive after long vowels in Ngizm (saa[r]a 'peer' versus saa[r]a 'a loan; a thing lent')

\[
\begin{array}{ll}
\sigma & \sigma \\
\text{C V V C V} & \text{C V V C V} \\
\text{s a r u} & \text{s a r u}
\end{array}
\]

Similarly, the trill is predicted to pattern as a single consonant with respect to reduplication in Kaliai-Kove, which copies only the first CVC string of the base word:

(5.14) Trill patterns as single phonological unit in Kaliai-Kove reduplication ([i`yare] 'he copulates' \(\rightarrow\) [i`yaryare] 'he copulates (durative)')

\[
\begin{array}{ll}
\sigma & \sigma \\
\text{V C V C V} & \text{V C V C V C V} \\
\text{i`y a r e} & \text{i`y a r y a r e}
\end{array}
\]

Finally, the trill surfaces in complex onsets and coda position in Kairiru without producing illicit syllable structures, precisely because it is a single phonological unit:
(5.15) Tap and trill are contrastive in complex onsets and coda position in Kairiru

a. [aqrei] 'it is raining' versus [qrapʰam] 'your shoulder'

\[
\begin{array}{c}
\sigma \\
V C C V V \\
a q r e i \\
\end{array}
\quad \text{versus} \quad \\
\begin{array}{c}
\sigma \\
C C V C V C \\
q r a pʰ a m \\
\end{array}
\]

a. [wʊr] 'crayfish' versus [wʊr]'banana'

\[
\begin{array}{c}
\sigma \\
C V C \\
w o r \\
\end{array}
\quad \text{versus} \quad \\
\begin{array}{c}
\sigma \\
C V C \\
w o r \\
\end{array}
\]

On the other hand, the behavior of the trill as a morphologically derived sequence of taps in Palauan and Kurdish constitutes evidence in favor of the cluster representation in (5.1a) or the dually-linked structure in (5.1b). What needs to be explained here is the fact that when two taps become adjacent in the derivation, they are realized phonetically as a single trill. As I will show in the following sections, the phonetically-based OT analysis already provides the means necessary for explaining the neutralization of rhotic clusters.

5.3.1 Neutralization of Postlexical Rhotic Clusters in Iberian Romance

Recall that in Iberian Romance languages, a word-final tap is deleted when it precedes a word-initial alveolar trill. Harris (1983:63) cites the examples in (5.16) to show that postlexical sequences of tap + trill are neutralized to trill in Spanish:
Postlexical rhotic sequences in Spanish (Harris 1983:63)

a. salí rápido    [sali rapiðo]    'I left rapidly'
salir rápido    [sali rapiðo]    'to leave rapidly'

b. gamba rara    [gamba rara]    'strange shrimp'
ambar raro    [amba raro]    'strange amber'

In Section 3.3.5 of Chapter 3, I proposed an analysis of this neutralization pattern which incorporates the targeted constraint shown in (5.17):

(5.17)  NO\text{WEAKRHTIC}

Let \( x \) be any candidate and \( \varsigma \) be any rhotic in \( x \) that is perceptually weak. If candidate \( y \) is exactly like \( x \) except that \( \varsigma \) has been removed, then \( y \) is more harmonic than \( x \).

Specifically, the deletion of word-final taps is accounted for by the ranking of NO\text{WEAKRHTIC} over the constraint LEx(segment), which reflects a lexical conservatism condition enforcing the conservation of lexically specified segments. On the assumption that the tap + trill cluster is perceptually equivalent to a single trill, NO\text{WEAKRHTIC} asserts that the latter is more harmonic than the former (i.e., VlrV \( > \) VlrV) early on in the cumulative harmonic ordering. While the opposite ordering (i.e., VlrV \( > \) VlrV) is asserted by lower-ranked LEx(segment), this ordering cannot be added to the cumulative ordering because it contravenes the one already established by higher-ranked NO\text{WEAKRHTIC}. As a result, deletion of the word-final tap is the optimal way to repair the postlexical cluster.\textsuperscript{76}

\textsuperscript{76} See Section 3.3.5.2 of Chapter 3 for a more detailed discussion of order-based optimization, targeted constraints, and postlexical rhotic clusters in Iberian Romance.
5.3.2 Neutralization of Morphologically Derived Rhotic Clusters

I propose that the behavior of the trill as a morphologically derived geminate tap in Palauan and Kurdish stems from the same constraint posited to account for the neutralization of postlexical sequences in Iberian Romance, namely NOWEAKRHOTIC. Whereas this constraint results in the deletion of a word-final tap before an alveolar trill across the word boundary, NOWEAKRHOTIC forces the coalescence of two adjacent taps into a single trill within the word. To see this, consider the representation of an intervocalic cluster of taps versus that of an intervocalic trill, shown in (5.18):

(5.18) Intervocalic cluster of taps versus singleton trill

\[
\begin{align*}
\text{a. } & V \text{} [\rho] \text{} [\rho] V \\
& \text{cor} \quad \text{cor} \\
& A_v \quad A_t A_m A_t \quad A_v \\
\text{b. } & V \text{} [\rho] V \\
& \text{cor} \\
& A_v \quad A_t \quad A_v
\end{align*}
\]

It should be noted that (5.18a) assumes that such a configuration is even possible on physiological grounds. As pointed out during the discussion of the articulatory properties of trills in Section 3.1.2.2 of Chapter 3, the trill involves a production mechanism that is different from that of the tap:\(^{77}\)

"A flap … is a single ballistic flick or hit-and-run gesture. A trill … is a maintained and prolongable posture: the vibrations that occur in a trill are aerodynamically imposed on the posture. Any idea that a trill is a 'rapid series of flaps', or that a flap is just an 'ultra-short trill' is quite wrong. The frequency of alveolar and uvular trills [r] and [ʃ] is of the order of 30

---

\(^{77}\) Recall that Catford (1977) uses the term flap in referring to lingual articulations of extra-short constriction duration. Here, I continue to employ the term tap as synonymous with Catford's terminological designation.
cycles per second. This is much higher than the maximum rate at which one can produce a series of [r]-flaps (about five or six per second)" (Catford 1977:130).

For the sake of discussion, however, I shall assume that the representation of the trill as a sequence of taps is a possibility. Such a move will allow us to examine claims, albeit hypothetical, regarding the perceptual equivalence of tap + tap clusters and single trills.

In (5.18a), a single A_m position serves as both the release position of the first tap and the approach position of the second due to merger of adjacent identical aperture nodes. This articulatory configuration presumably yields an acoustic representation in which a brief period of greater aperture intervenes between two constriction periods, with vocalic aperture ensuring flanking sonority on either side of the entire sequence. This acoustic structure is identical to that of a single trill, which typically has at least two or more constriction periods. Therefore, it is plausible that speakers would interpret the sequence of constrictions resulting from (5.18a) as perceptually equivalent to that produced by the single trill in (5.18b). That is to say, a sequence of taps is not easily distinguishable from a single alveolar trill. Figures 5–1 and 5–2 illustrate the perceptual equivalence of a tap + tap sequence and a single two-contact trill:
As these figures show, a sequence of two adjacent taps produces a total of two stop-like moments alternating with greater periods of sonority—precisely the same acoustic result of a single two-contact alveolar trill. That is, both of the taps in (5.18a) may be

*Figure 5–1*: Sequence of tap + tap yields an acoustic representation consisting of two interruptions of surrounding vocalic aperture

*Figure 5–2*: Single two-contact alveolar trill yields an acoustic representation consisting of two interruptions of surrounding vocalic aperture
considered to be perceptually weak, given that their adjacency is not easily distinguished from the single trill in (5.18b).

In the case of morphologically derived tap + tap clusters, the targeted constraint NOWEAKRHOTIC prefers a candidate that is exactly like a cluster except that the perceptually weak taps have been removed. The preferred candidate is the one containing a single trill, as in (5.18b), because this rhotic is perceptually equivalent to a cluster of taps and the individual $A_mA_nA_m$ tap gestures are no longer present. Specifically, I assume that the sequence in (5.18a) undergoes coalescence to the single trill of (5.18b), which incurs a violation of the constraint in (5.19):

\[
\text{(5.19) } \text{LEX(precedence)} \\
\quad \text{Given } T(W), \text{ the form of a word } W \text{ appearing under evaluation, and } L(W), \text{ the lexically listed form of } W, \text{ the precedence structure of } L(W) \text{ is conserved in } T(W).
\]

LEX(precedence) ensures preservation of the relative linear ordering among segments in lexically listed forms of words (cf. the LINEARITY constraint of McCarthy and Prince 1995). For instance, if segment A precedes segment B in the lexically listed form, then A must precede B also in the form under evaluation. If A and B coalesce into a single segment, then the precedence relation no longer holds, and LEX(precedence) is violated.

I propose that the ranking of NOWEAKRHOTIC » LEX(precedence) guarantees coalescence. Recall that in Section 3.3.5 of Chapter 3, the deletion of word-final taps before word-initial alveolar trills in Iberian Romance was argued to result from the ranking of NOWEAKRHOTIC » LEX(segment). In the present case of morphologically derived cluster coalescence, however, LEX(precedence) is the relevant constraint. The
reason for this difference is that lexical precedence relations are calculated relative to individual words. Rhotic coalescence across the word boundary (i.e., $Vlr_{1,2}V$ versus $Vr_1|r_2V$) would not violate $\text{LEX}(\text{precedence})$ because the linear ordering of the rhotic with respect to other segments within each word would remain the same. That is, the rhotic in a coalesced $Vlr_{1,2}V$ sequence still follows the segments of the first $L(W)$ and still precedes the segments of the second $L(W)$. Therefore, postlexical cluster neutralization must be analyzed as deletion instead of coalescence.78

Let us examine how the ranking of $\text{NOWEAKRHOTIC} \gg \text{LEX}(\text{precedence})$ yields coalescence of a morphologically derived tap cluster to a single trill. For convenience and ease of reference, I repeat the definition of order-based optimization from Chapter 3 below. Tableau (5.21) shows how $\text{NOWEAKRHOTIC}$ favors coalescence. (N.B.: Subscripts are used to indicate that the single trill in (5.21b) is in multiple correspondence with the taps of the cluster in the lexically listed form.)

78 Eric Bakovic (personal communication) suggests that a deletion analysis may also be possible in the case of morphologically derived tap clusters. However, I shall not pursue such an analysis at present.
(5.20) Order-based optimization (adapted from Wilson 1999:22)

a. *Ordering*
   Starting with the highest-ranked constraint in the hierarchy, if the current
   constraint asserts the ordering \( x \succ y \), then add \( x \succ y \) to the cumulative
   ordering \( O \), except when the opposite ordering (i.e., \( y \succ x \)) is in \( O \). Repeat
   for the next highest-ranked constraint in the hierarchy.

b. *Transitive Closure*
   For any candidates \( x \), \( y \), and \( z \), if both \( x \succ y \) and \( y \succ z \) are in the
   cumulative ordering \( O \), then \( x \succ z \) is also in \( O \) (i.e., \( x \succ y \) & \( y \succ z \Rightarrow x \succ z \)).

c. *Optimality*
   A candidate is optimal iff it is not worse than any other candidate in the
   final cumulative ordering (i.e., when the loop in (a) ends).

(5.21) Targeted contextual markedness ensures neutralization of tap + tap cluster to
single trill

<table>
<thead>
<tr>
<th></th>
<th>( \Rightarrow \text{NOWEAKRHOTIC} )</th>
<th>LEX(precedence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>( Vr_1r_2V )</td>
<td>( Vr_1r_2V \succ Vr_1r_2V )</td>
</tr>
<tr>
<td>( \neq ) b.</td>
<td>( Vr_{1,2}V )</td>
<td>( (Vr_1r_2V \succ Vr_{1,2}V) )</td>
</tr>
<tr>
<td>c.</td>
<td>( Vr_1V )</td>
<td>( Vr_1r_2V \succ Vr_1V )</td>
</tr>
<tr>
<td>d.</td>
<td>( Vr_2V )</td>
<td>( Vr_1r_2V \succ Vr_2V )</td>
</tr>
<tr>
<td>Cumulative ordering:</td>
<td>( Vr_{1,2}V \succ Vr_1r_2V )</td>
<td>( Vr_{1,2}V \succ Vr_1r_2V \succ Vr_1V )</td>
</tr>
</tbody>
</table>

Candidate (a) violates NOWEAKRHOTIC because it contains a perceptually weak cluster
of taps. Since this constraint is targeted, it asserts that the coalescence candidate (b) is
more harmonic than (a), i.e., \( Vr_{1,2}V \succ Vr_1r_2V \), because the two are otherwise identical.
except that the perceptually weak taps are absent from the former.\textsuperscript{79} This harmonic ordering is added to the cumulative ordering in the bottom row.

Next, the LEX\textit{(precedence)} constraint is violated by candidates (b–d) because in each case, the first rhotic no longer precedes the second as it does in the lexically listed form. LEX\textit{(precedence)} asserts that candidate (a) is more harmonic than candidate (b), i.e., $V_{r_1r_2}V \succ V_{r_1}V$. Observe that this ordering is the exact opposite of the one asserted by higher-ranked NOWEAKRHOTIC, $V_{r_1,2}V \succ V_{r_1}V$. According to the order-based optimization procedure in (5.20a), an ordering is added to the cumulative ordering except when the \textit{opposite} ordering is already there by virtue of some higher-ranked constraint. Since $V_{r_1,2}V$ was already deemed more harmonic than $V_{r_1}V$ by NOWEAKRHOTIC, LEX\textit{(precedence)} cannot change the relative harmony of the two candidates.

With respect to candidates (c) and (d), LEX\textit{(precedence)} again asserts the greater harmony of candidate (a), i.e., $V_{r_1}V \succ V_{r_1,2}V$ and $V_{r_1}V \succ V_{r_2}V$. When this ordering is added to cumulative ordering, we see the effects of transitive closure, defined in (5.20b). Thus far in the evaluation, NOWEAKRHOTIC has already placed candidate (b) over (a) in the cumulative ordering. When LEX\textit{(precedence)} places candidate (a) over (c) and (d),

\textsuperscript{79} It is not the case that candidates $V_{r_1,2}V$ and $V_{r_1}r_2V$ are "otherwise identical" due to the formal relation of multiple correspondence. The notion of perceptual similarity underlying Wilson's (1999) theory of targeted constraints is purely phonetic and not formal in this way. Rather, $V_{r_1,2}V$ in (5.21b) has an acoustic representation identical to that of $V_{r_1}r_2V$ in (5.21a), as illustrated in Figures 5–1 and 5–2 above. The difference is that the perceptually weak AmAtAm tap gestures are absent from the former candidate. Thanks to Eric Bakovic for discussion on this point.
then (b) is also more harmonic than both (c) and (d) by transitivity. Thus we arrive at the final cumulative ordering \( Vr_1,2V > Vr_1,2V > \{Vr_1V, Vr_2V\} \).\(^80\) Since candidate (b) is the most harmonic of the four candidates, it emerges as optimal according to (5.20c).

The analysis of hypothetical forms in tableau (5.21) provides a basis for understanding the behavior of the trill as a morphologically derived sequence of taps in Palauan and Kurdish. Specifically, the ranking of NOWEAKRHOTIC » LEX(precedence) enforces coalescence at the expense of sacrificing lexical precedence relations. In Palauan, the formation of the past perfective verbal form \([diru] \) 'burned/barbequed it', shown in (5.11), liquid assimilation produces a cluster of adjacent taps that is realized as a single trill. Coalescence is illustrated in (5.22):

(5.22) Coalescence in Palauan past perfective verbal formation (see (5.11))

\[
\begin{array}{c}
\text{modil}_1 \text{ul}_2 \text{ur} \\
\text{dir}_1,2 \text{ur}
\end{array}
\]

\( l_1 \) precedes \( l_2 \) in \( L(W) \)

\( \text{correspondent of } l_1 \) no longer precedes \( \text{correspondent of } l_2 \) in \( T(W) \)

To be sure, a complete analysis of the morphological relatedness of \( L(W) \) and \( T(W) \) would require additional constraints on the realization of morphemes, as well as constraints responsible for liquid assimilation.\(^81\) For present purposes, however, (5.22)

---

\(^80\) Since no other constraint asserts the relative harmony of candidates (c) and (d) with respect to each other, they remain equally harmonic in the final cumulative ordering.

\(^81\) Furthermore, it must be assumed that the resulting trill somehow satisfies the liquid assimilation constraint, since this process occurs at an intermediate stage in the rule-based analysis.
suffices to illustrate how the ranking of NOWEAKRHOTIC \( \rightarrow \) LEX(precedence) results in the coalescence of two lexically listed segments.

The same analysis is relevant in the case of Kurdish passive affixation, shown in (5.12b). Specifically, the affixation of the passive tap morpheme to a tap-final verb stem yields a sequence of adjacent taps. Coalescence is illustrated in (5.23):

\[
\text{(5.23) Coalescence in Kurdish passive affixation (see (5.12b))}
\]

\[
\text{?əŋe}_r_{1,2}e \quad r_1 \text{ precedes } r_2 \text{ in } L(W)
\]

As in the case of Palauan past perfective verbal formation, the ranking of NOWEAKRHOTIC \( \rightarrow \) LEX(precedence) in Kurdish ensures the coalescence of adjacent taps into a single phonetic trill at the expense of lexical precedence relations.

5.3.3 Summary

This chapter has reviewed evidence from several languages that the trill must be analyzed as a single phonological unit. On the other hand, evidence from other languages suggests that the trill is also the phonetic reflex of a sequence of taps arising in morphological derivation. As we have seen in Section 5.3, the phonetically-based OT account adequately captures the behavior of the trill in both cases. The success of the analysis stems from the fact that (1) both tap and trill are treated as phonological singletons and
(2) morphologically derived tap clusters are forced to neutralize to a single trill via segmental coalescence.

5.4 Concluding Remarks

5.4.1 Summary of Main Results

The empirical contribution of this dissertation has been to demonstrate how the distributions of the coronal tap and trill in Iberian Romance fit in among a more extensive typology of rhotic patterns. As a result of this broader typological perspective, several generalizations were uncovered with respect to rhotic duration contrast and neutralization. The theoretical contribution of this dissertation has been to develop an analysis that accounts not only for the Iberian Romance patterns but for all typologically attested patterns. In Chapter 2, previous syllable-based accounts of Spanish rhotics were shown to be inadequate when data from other languages are taken into consideration. A phonetically-based OT analysis was developed and illustrated on the basis of Iberian Romance in Chapter 3, then subsequently extended to other languages of the typology in Chapter 4. Finally, this chapter has shown how the ambiguous nature of the surface trill falls out naturally from proposed account.

The theoretical proposals made here connect with and lend support to recent advances in general phonological theory. First, the dissertation furthers our understanding of the role of phonetics in the characterization of phonological grammars. Phonotactic
patterns involving tap and trill are argued to follow from the interaction of perceptually grounded contrast constraints with articulatory markedness constraints. Positional preferences in the maintenance of rhotic duration contrast derive from the perceptual salience of phonetic cues in different contexts, which supports the theory of cue-based licensing (Steriade 1995a, 1997, 1999a, 2001a). Phonotactic restrictions on the distribution of tap and trill are formulated as syllable-independent constraints, which strengthens Steriade's Segmental Autonomy hypothesis. Second, the typological generalizations regarding rhotic duration contrast and neutralization are successfully captured in an analysis incorporating constraints that are ranked and violable. In Optimality Theory, a typology of predicted grammars constitutes the set of distinct grammars predicted by different rankings of the same set of constraints. In Chapter 4, different rankings of phonetically-grounded contrast and markedness constraints were shown to predict the full range of phonotactic patterns attested in the rhotic duration typology. Finally, in this chapter we have seen how the targeted constraint NOWEAKRHOTIC explains the ambiguous nature of the surface trill, which sometimes surfaces as the phonetic reflex of morphologically derived tap clusters.
5.4.2 Issues for Future Investigation

5.4.2.1 Phonetic Variation in The Cross-dialectal Realizations of Rhotics

Previous analyses of Spanish rhotics are based on only the most prototypical realizations of the tap and trill. These accounts tend to trivialize dialectal variants, relegating them to the category of "low-level" phonetic detail. The following passage from Harris (1983) is representative of the tendency to abstract away from phonetic reality:

"There is an astonishing variety of r-quality phones in Spanish. A phonetics teacher from whom I took undergraduate courses in Mexico claimed to have identified over 40 types of r in the Valley of Mexico alone. Fascinating though this fact is, it leaves open the question of how the phonological system of Spanish works. [...] I thus reduce the vocabulary of symbols to just two, [r] and [ɾ], which will be understood to jointly exhaust the rich phonetic variety mentioned at this beginning of this paragraph. [...] Of course, these are only the prototypical realizations. I will say little more about phonetic detail..." (62).

Subsequently, Spanish phonologists have made similar empirical assumptions, basing their analyses upon only the basic distributional properties of the tap and trill while ignoring much of the dialectal variation underlying the phonetic reality of these segments.

More recent investigations of the Spanish tap and trill have begun to redress the lack of attention given to phonetic detail in previous studies. For instance, Hammond (1999) conducted an acoustic investigation of the realizations of the trill among speakers from more than 35 Spanish dialects. Contrary to the linguistic norm prescribed by the Real Academia Española (1924, 1979, 1992) and to the prototypical pattern assumed by
theoretical accounts, Hammond claims that the standard multiple vibrant trill simply does not occur in the speech of the vast majority of native Spanish speakers. Dialectal variants of the trill exhibit a range of articulations, including a voiceless velar or uvular fricative, a retroflex, a preaspirated tap, a partially devoiced tap, and a simple voiced tap. Furthermore, Hammond claims that phonetic variation often results in neutralization of intervocalic contrast.82

Not all researchers agree with Hammond's findings, however. Inouye (1995) measured the duration of intervocalic trills of speakers from Peru and Northern Mexico in order to determine whether the contrast between tap and trill is ever neutralized. Only 1% of the intervocalic trills examined in her study were reduced to tap, "in an apparent attempt to avoid neutralization with the tap in this position" (Inouye 1995:284). Similarly, Willis and Pedrosa (1998) investigated the duration of taps and trills of speakers of peninsular Spanish and found that contrastiveness was typically maintained in intervocalic position through number of occlusions and/or overall duration. Moreover, trills were realized as multiple vibrants 86% of the time. These findings run counter to the claims made by Hammond (1999) that the standard multiple vibrant trill is virtually non-existent in normal Spanish discourse in most dialects and that phonetic variation often results in loss of tap/trill contrast in intervocalic position.

82 Thanks to Fernando Martínez-Gil for reminding me of this particular observation made by Hammond (1999).
In light of the ongoing debate regarding cross-dialectal realizations of rhotics in Spanish (and more generally, Iberian Romance), some questions for future research in this area include the following:

1. What is the frequency of occurrence of the standard multiple vibrant trill in different Spanish varieties?
2. What are the major phonetic variants of the standard trill? What phonetic parameters of differentiation are observed (e.g., place of articulation, manner specifications, voicing)?
3. To what extent is the contrast between the tap and trill neutralized in intervocalic position?
4. In the absence of a standard trill articulation, what compensatory measures, if any, do speakers employ to maintain perceptual distinctiveness of the two r-sounds in the contrastive intervocalic position?

Answers to questions such as these will have important implications for the phonetically-based OT analysis developed and illustrated throughout this dissertation. Since the analysis posits that phonetic implementation plays a direct role in the maintenance and neutralization of contrast, dialectal variation in the phonetic realization of rhotics cannot be simply dismissed as irrelevant. We have already seen one revealing case in Section 3.3.4.2 of Chapter 3, namely devoicing and preaspiration in Dominican Spanish. It was argued that devoicing of the trill combines with alternate oral-glottal gestural timing in such a way as to allow preservation of rhotic duration contrast, despite temporal reduction of the lingual trill gesture. In this case, lexical conservatism—specifically,
LEX(duration)—places limits on phonetic variation: rhotic devoicing and preaspiration timing must accompany lenition to tap in order to avoid neutralization of lexical contrasts. Further investigation is needed to determine how other types of phonetic variation interact with contrast preservation and how such interaction can be integrated into the analysis proposed here.

5.4.2.2 Perceptibility Conditions on The Surface Distribution of Coronal Tap

In Section 3.1.1 of Chapter 3, a discussion of the articulatory and perceptual characteristics of the coronal tap revealed certain distributional preferences with respect to this segment. Specifically, Walsh (1997:96) notes that cross-linguistically, taps exhibit a preference for intervocalic position (inter-sonority) and tend to avoid word-edges (anti-peripherality) in order to maintain sonority and enhance perceptibility. With respect to languages in which taps cluster with consonants, a svarabhakti vowel fragment typically intervenes between the tap and the adjacent consonant. The vowel fragment is also present following word-final taps before pause. In Section 3.1.1.2, it was argued that the presence of svarabhakti in non-intervocalic positions depends on the degree of gestural overlap between the tap and the tautosyllabic vowel. The preference for intervocalic position stems from the greater likelihood that svarabhakti will be perceptually compromised in non-intervocalic positions due to variability in gestural timing.

These considerations were taken as motivation for the low ranking of the context-free CONTRAST(duration) constraint within the universal hierarchy shown in (5.24):
Specifically, this part of the phonological grammar encapsulates the speaker's knowledge that the contrast between tap and trill is most perceptible in intervocalic position, less perceptible in word-initial position, and least perceptible elsewhere, namely word-finally and in heterorganic clusters.\(^8\) The ranking of $\text{CONTRAST}($duration$)$ within the hierarchy in (5.24) stems from the fact that loss of the svarabhakti vowel presumably diminishes the perceptibility of the tap, which may subsequently be interpreted by the listener as reduced or, in the extreme case, elided. The same threat does not exist in intervocalic contexts, where the flanking vowels provide an optimal acoustic backdrop and facilitate the approach and release phases of the ballistic tapping gesture, nor in word-initial contexts, which benefit from the inherent perceptual prominence of word onsets.

To my knowledge, no perception-based studies exist in the literature to support the hypothesis that the loss of svarabhakti leads to diminished perceptibility of the tap. Clearly, future experimental research must be undertaken in order to verify such a claim. One possible approach is to present listeners with randomized, recorded tokens of minimal pair words with the tap appearing in those segmental contexts in which gestural overlap could potentially lead to the loss of svarabhakti, i.e., pre- and postconsonantal and word-final. The taps of some tokens would exhibit both the normal stop-like interruption of formant structure as well as a svarabhakti vowel fragment intervening between the interruption and an adjacent consonant or pause. Other tokens, however,
could be digitally altered by splicing out the intervening vowel fragment, such that the stop-like interruption is fully adjacent to the consonant or pause in the waveform.\textsuperscript{84} A perceptual discrimination task would engage listeners in the classification of tokens as either containing or lacking a tap—not explicitly, but rather through the association of a given token with some semantic context.

For example, the Spanish words \textit{curva} [kúr'βa] 'curve, a curved line' and \textit{Cuba} [kúβa] 'Cuba' constitute a minimal pair with respect to the preconsonantal tap. Both tokens possess identical stress configurations and segmental composition, except that the tap is present in the former but absent from the latter. A pre-recorded token of [kúr'βa] may be digitally altered in order to remove the vowel fragment, thereby yielding [kúrβa], where the tie bar indicates the absence of the fragment. Upon hearing the altered token, listeners could be forced to choose among several pictures, which minimally include a curved line and a map of the Caribbean in which Cuba is highlighted. Selection of the curved line would indicate that the modified token was perceived as \textit{curva}, while selection of the map of Cuba would suggest its perception as \textit{Cuba}. If acoustically modified tokens are consistently classified by listeners as lacking a tap, then this would constitute evidence in favor of the hypothesis that loss of svarabhakti leads to the diminished perceptibility of this segment.

\textsuperscript{83} Recall that the articulatory constraint *FAST/SAME SITE ensures neutralization to trill in homorganic (i.e., Place/stricture-sharing) clusters.\textsuperscript{84} Orhan Orgun (personal communication) suggests an alternate approach involving the insertion of silence in place of the svarabhakti vowel.
A similar experimental procedure may also shed light on the issue of rhotic cluster neutralization. According to the targeted constraints analysis proposed in Section 3.3.5 of Chapter 3, word-final taps are deleted before word-initial alveolar trills in Iberian Romance because the resulting clusters are perceptually indistinguishable from single three-contact trills. In Section 5.3.2 of this chapter, a similar account was given of the neutralization of morphologically derived tap + tap clusters, which are argued to be perceptually equivalent to single two-contact alveolar trills. With respect to postlexical cluster neutralization, a perception-based experiment might involve the creation of tokens in which a word-final tap abuts a word-initial trill, such as salir rápido [saliɾiɾapiɾo] 'to leave rapidly'. A discrimination task similar to that proposed for the curva/Cuba example above might yield results bearing on the question of whether listeners perceive a token such as [saliɾiɾapiɾo] as either equivalent to or distinct from one in which the word-final tap is truly absent, i.e., salí rápido [salĩɾapiɾo] 'I left rapidly'. This approach may prove somewhat more difficult in the case of intramorphemic tap + tap cluster neutralization, since the absence of minimal pair tokens of the form [Vr’rV] versus [VrV] precludes the use of perceptual discrimination tasks involving semantic identification. However, one possibility would be to employ tokens based on pairs such as pero [pero] 'but' versus perro [pero] 'dog', with digitally created tokens such as [perɾ’ɾo] supplanting the latter. Consistent classification of modified [Vr’rV] tokens as contrastive with [VrV] ones would constitute evidence in favor of the claim that [Vr’rV] and [VrV] sequences are
indistinguishable, i.e., that tap + tap clusters are perceptually equivalent to single alveolar trills.\textsuperscript{85}

\textsuperscript{85} Barbara Bullock (personal communication) points out that the relative phonetic duration of the preceding vowel may also be a significant cue to distinctive rhotic duration in that \( V_1 \) may plausibly be longer before a tap but shorter before a trill. If so, then the case of tap/trill contrast would parallel that of distinctive voicing in English obstruents, where the phonetic effect of vowel lengthening is observed before voiced stops vis-à-vis voiceless ones: \textit{bead} [bi:d] versus \textit{beat} [bit] (see Keating 1984).


Spanish Phonology Present and Past. Romance Phonology and Variation ed. by C.

Lingüística ALFAL 1:7–44.


University of Los Angeles, California.

Itô, Junko, R. Armin Mester and Jaye Padgett. 1993. Licensing and Redundancy:
Research Center, University of California, Santa Cruz.

Itô, Junko, R. Armin Mester and Jaye Padgett. 1995. Licensing and Underspecification in

Jakobson, Roman and Morris Halle. 1962. Phonology and Phonetics. Roman Jakobson

Jiménez Sabater, Max. 1975. Más datos sobre el español de la República Dominicana.
Santo Domingo: Ediciones INTEC.

Hawaii.

Press.


Steriade, Donca. 1990. Gestures and Autosegments: Comments on Browman and
Goldstein's Paper. Papers in Laboratory Phonology 1: Between the Grammar and
Physics of Speech ed. by John Kingston and Mary Beckman, 382–397.
Cambridge: Cambridge University Press.

Press.

Perspectives in Phonology ed. by J. Cole and C. Kisseberth, 203–291. Stanford:
CSLI.

Steriade, Donca. 1995a. Licensing Retroflexion. Ms., University of California, Los
Angeles.


Ms., University of California, Los Angeles.

Steriade, Donca. 1999a. Alternatives to the Syllabic Interpretation of Consonantal

Steriade, Donca. 1999b. Lexical Conservatism in French Adjectival Liaison. Formal
Perspectives on Romance Linguistics ed. by J.–M. Authier, B. Bullock and L.


