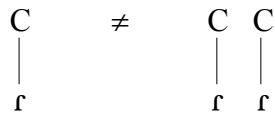


## Chapter 5

### 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)



b. Trill as a dually-linked geminate tap (Lipski 1990; Núñez Cedeño 1988, 1994)



c. Trill as a single phonological unit (Bakovic 1994; Bonet and Mascaró 1997; Morales-Front 1994)



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):

- (5.2) a. Tap:  $\begin{array}{c} \text{cor} \\ \diagup \quad \diagdown \\ \text{A}_m \text{A}_t \text{A}_m \end{array}$  = approach + constriction + release
- b. Trill:  $\begin{array}{c} \text{cor} \\ | \\ \text{A}_t \end{array}$  = constriction

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

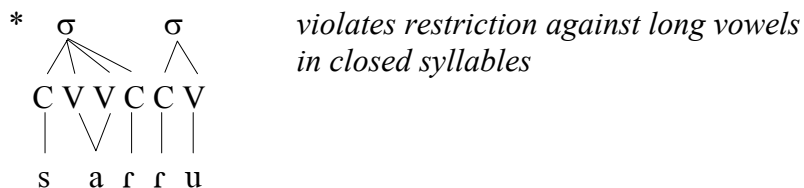
Schuh (1981) observes that modulo a few rare exceptions, long vowels do not occur in closed syllables in Ngizim. Now, consider the data in (5.3) below, in which the trill surfaces after long vowels.

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

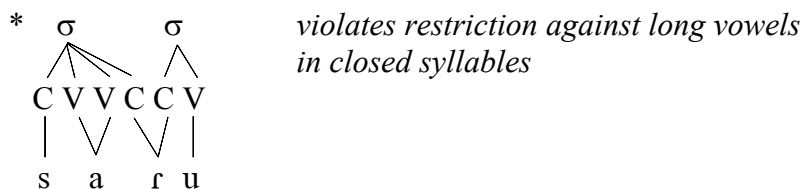
[ji:re]	<i>jiĩre</i>	'truth'
[ma:gi:ra]	<i>maagiĩra</i>	'leader of the women in a town'
[nas:ra]	<i>nasaaĩra</i>	'European'
[sar:u]	<i>saaĩru</i>	'peer'

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):

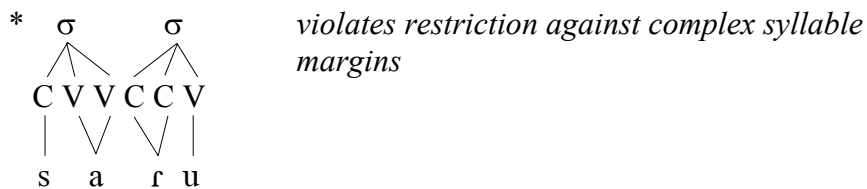
- ( 5.4 ) a. Trill as heterosyllabic cluster of taps



- b. Trill as heterosyllabic dually-linked geminate tap



- c. Trill as tautosyllabic dually-linked geminate tap



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. RED + C<sub>1</sub>VC<sub>2</sub>V → C<sub>1</sub>VC<sub>2</sub>C<sub>1</sub>VC<sub>2</sub>V
- b. /βole/ 'boar's tusk'  
 /RED + βole/ → [βolβole] '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  
 /iyare/ 'he copulates'  
 /i + RED + yare/ → [iyaryare] 'he copulates (durative)'
- b. Trill as heterosyllabic geminate tap  
 /i + RED + yarre/ → \*[iyaryare]

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. [yrem] 'somewhat, slightly'  
 [mokrɯp] 'frog'
- b. [m̥barku] 'spirit mask type'

If the trill is a cluster or dually-linked geminate, then these would be three-consonant clusters (e.g., /yrr/, /krr/, /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 <sup>h</sup> am] | 'your shoulder'     |
| b. | [pur]         | 'pig'               | [ɲar]                   | '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 + dul + úr/ (basic form: verb marker + verb stem + object pronoun)

d + mə + ul + úr (by metathesis)

d + m + ul + úr (by deletion of ə)

d + u + ul + úr (by change of verb marker to u in unstressed syllable)

d + ul + úr (by deletion of verb marker)

d + ur + úr (by assimilation of l to r)

[durúr] '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 [durúr].

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 + úr/ (basic form, including infix past tense marker –il)

d + mə + il + ul + úr (by metathesis)

d + m + il + ul + úr (by deletion of ə)

d + u + il + ul + úr (by change of verb marker to u in unstressed syllable)

d + il + ul + úr (by deletion of verb marker)

d + il + l + úr (by deletion of unstressed u)

d + il + r + úr (by assimilation of l to r)

d + ir + r + úr (by assimilation of l to r)

[dirúr] '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 /r/ in Kurdish (Abdulla and McCarus 1967)

	<u>Active form</u>		<u>Passive form</u>	
a.	ʔəzɑ̃ɾɛ	'he knows'	ʔəzɑ̃ɾɛrɛ	'he is known'
b.	ʔəɾɛrɛ	'he sends'	ʔəɾɛrɛrɛ	'he is sent'

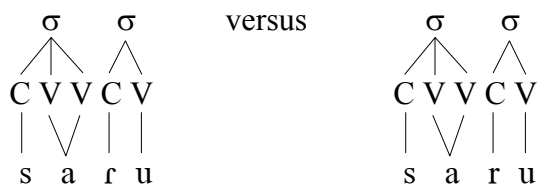
As shown in (5.12b), two taps that come to be adjacent in the derivation are realized as a single surface trill. This suggests that the Kurdish trill is sometimes a morphologically derived cluster of taps, similar to the Palauan trill.

### 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

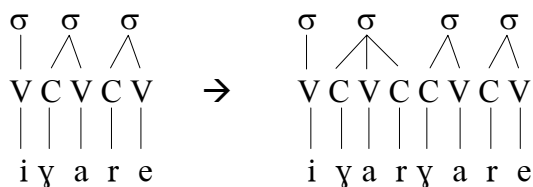
that it should be able to appear after long vowels. This is exactly the case in Ngizim, where tap and trill contrast intervocalically after a long vowel:

- (5.13) Tap and trill are contrastive after long vowels in Ngizim (*saa[r]a* 'peer' versus *saa[r]a* 'a loan; a thing lent')



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:

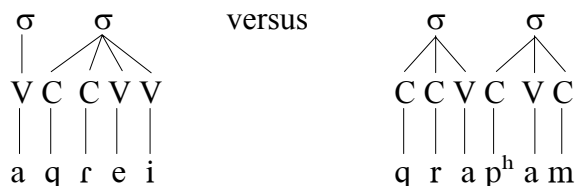
- (5.14) Trill patterns as single phonological unit in Kaliai-Kove reduplication ([iɣare] 'he copulates' → [iɣaryare] 'he copulates (durative)')



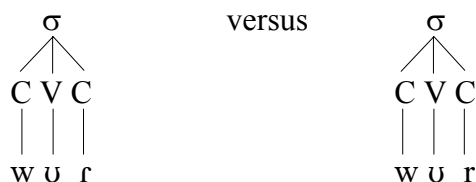
Finally, the trill surfaces in complex onsets and coda position in Kairiru without producing illicit syllable structures, precisely because it is a single phonological unit:

(5.15) Tap and trill are contrastive in complex onsets and coda position in Kairiru

a. [aqrei] 'it is raining' versus [qrap<sup>h</sup>am] 'your shoulder'



a. [wʊr] 'crayfish' versus [wʊr] 'banana'



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:

## (5.16) Postlexical rhotic sequences in Spanish (Harris 1983:63)

- |    |                     |               |                    |
|----|---------------------|---------------|--------------------|
| a. | <i>salí rápido</i>  | [sali rapiðo] | 'I left rapidly'   |
|    | <i>salir rápido</i> | [sali rapiðo] | 'to leave rapidly' |
| b. | <i>gamba rara</i>   | [gamba rara]  | 'strange shrimp'   |
|    | <i>ambar raro</i>   | [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) NOWEAKRHOTIC

Let  $x$  be any candidate and  $\zeta$  be any rhotic in  $x$  that is perceptually weak. If candidate  $y$  is exactly like  $x$  except that  $\zeta$  has been removed, then  $y$  is more harmonic than  $x$ .

Specifically, the deletion of word-final taps is accounted for by the ranking of NOWEAKRHOTIC 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, NOWEAKRHOTIC asserts that the latter is more harmonic than the former (i.e.,  $VlrV \succ VrIrV$ ) early on in the cumulative harmonic ordering. While the opposite ordering (i.e.,  $VrIrV \succ VlrV$ ) 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 NOWEAKRHOTIC. As a result, deletion of the word-final tap is the optimal way to repair the postlexical cluster.<sup>76</sup>

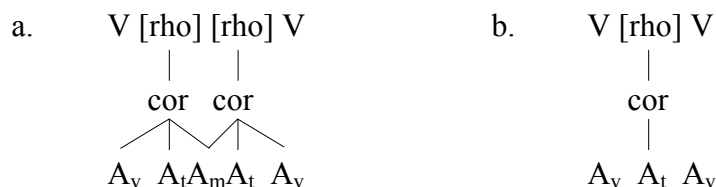
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<sup>76</sup> See Section 3.3.5.2 of Chapter 3 for a more detailed discussion of order-based optimization, targeted constraints, and postlexical rhotic clusters in Iberian Romance.

### 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



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:<sup>77</sup>

"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 [R] is of the order of 30

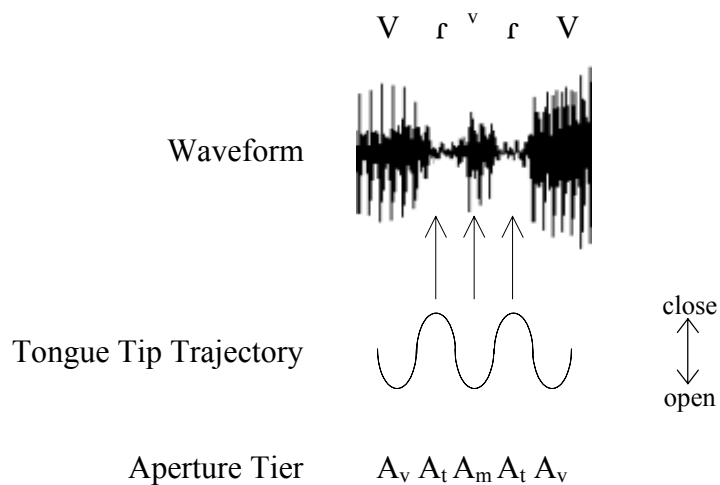
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<sup>77</sup> Recall that Catford (1977) uses the term *flap* in referring to lingual articulations of extra-short constriction duration. Here, I continue to employ the term *tap* as synonymous with Catford's terminological designation.

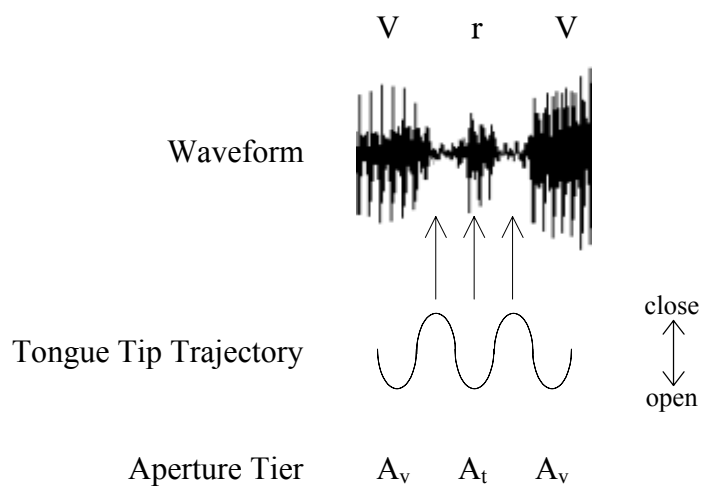
cycles per second. This is much higher than the maximum rate at which one can produce a series of [r]-flaps (about five or six per second)" (Catford 1977:130).

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:



*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

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

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  $A_m A_t A_m$  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):

(5.19) LEX(precedence)

Given  $T(W)$ , the form of a word  $W$  appearing under evaluation, and  $L(W)$ , the lexically listed form of  $W$ , the precedence structure of  $L(W)$  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.,  $V|r_1r_2V$  versus  $Vr_1|r_2V$ ) would not violate LEX(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  $V|r_1r_2V$  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.<sup>78</sup>

Let us examine how the ranking of NOWEAKRHOTIC » LEX(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 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.)

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<sup>78</sup> 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

	$\Rightarrow$ NOWEAKRHOTIC	LEX(precedence)
a. $V_{f_1f_2}V$	$V_{r_{1,2}}V \succ V_{f_1f_2}V !$	
$\Rightarrow$ b. $V_{r_{1,2}}V$		$(V_{f_1f_2}V \succ V_{r_{1,2}}V)$
c. $V_{f_1}V$		$V_{f_1f_2}V \succ V_{f_1}V !$
d. $V_{f_2}V$		$V_{f_1f_2}V \succ V_{f_2}V !$
<i>Cumulative ordering:</i>	$V_{r_{1,2}}V \succ V_{f_1f_2}V$	$V_{r_{1,2}}V \succ V_{f_1f_2}V \succ V_{f_1}V$ $V_{r_{1,2}}V \succ V_{f_1f_2}V \succ V_{f_2}V$

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.,  $V_{r_{1,2}}V \succ V_{f_1f_2}V$ , because the two are otherwise identical

except that the perceptually weak taps are absent from the former.<sup>79</sup> This harmonic ordering is added to the cumulative ordering in the bottom row.

Next, the LEX(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(precedence) asserts that candidate (a) is more harmonic than candidate (b), i.e.,  $Vr_1r_2V \succ Vr_{1,2}V$ . Observe that this ordering is the exact opposite of the one asserted by higher-ranked NOWEAKRHOTIC,  $Vr_{1,2}V \succ Vr_1r_2V$ . According to the order-based optimization procedure in (5.20a), an ordering is added to the cumulative ordering except when the *opposite* ordering is already there by virtue of some higher-ranked constraint. Since  $Vr_{1,2}V$  was already deemed more harmonic than  $Vr_1r_2V$  by NOWEAKRHOTIC, LEX(precedence) cannot change the relative harmony of the two candidates.

With respect to candidates (c) and (d), LEX(precedence) again asserts the greater harmony of candidate (a), i.e.,  $Vr_1r_2V \succ Vr_1V$  and  $Vr_1r_2V \succ Vr_2V$ . 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(precedence) places candidate (a) over (c) and (d),

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<sup>79</sup> It is not the case that candidates  $Vr_{1,2}V$  and  $Vr_1r_2V$  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,  $Vr_{1,2}V$  in (5.21b) has an acoustic representation identical to that of  $Vr_1r_2V$  in (5.21a), as illustrated in *Figures 5–1* and *5–2* above. The difference is that the perceptually weak  $A_m A_t A_m$  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  $Vr_{1,2}V \succ Vr_1r_2V \succ \{Vr_1V, Vr_2V\}$ .<sup>80</sup> 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 [dirúr] '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))

$\begin{array}{c} m\acute{a}d\acute{i}l_1u\acute{l}_2\acute{u}r \\ \swarrow \quad \searrow \\ d\acute{i}r_{1,2}\acute{u}r \end{array}$	$l_1$ precedes $l_2$ in $L(W)$  correspondent of $l_1$ no longer precedes correspondent of $l_2$ in $T(W)$
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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.<sup>81</sup> For present purposes, however, (5.22)

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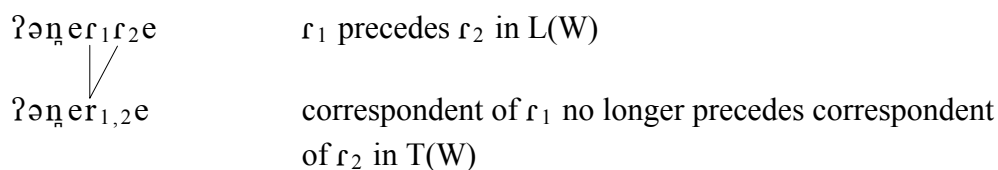
<sup>80</sup> Since no other constraint asserts the relative harmony of candidates (c) and (d) with respect to each other, they remain equally harmonic in the final cumulative ordering.

<sup>81</sup> 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 » 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):

(5.23) Coalescence in Kurdish passive affixation (see (5.12b))



As in the case of Palauan past perfective verbal formation, the ranking of NOWEAKRHOTIC » 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 [r̄], 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.<sup>82</sup>

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.

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<sup>82</sup> 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):

(5.24) Tap/trill contrast preservation hierarchy  
 CONTRAST(dur/V\_V) » CONTRAST(dur/#\_V) » CONTRAST(dur)

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.<sup>83</sup> The ranking of 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.<sup>84</sup> 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 *curva* [kúr<sup>u</sup>βa] 'curve, a curved line' and *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 [kur<sup>u</sup>βa] may be digitally altered in order to remove the vowel fragment, thereby yielding [kur̄βa], 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 *curva*, while selection of the map of Cuba would suggest its perception as *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.

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<sup>83</sup> Recall that the articulatory constraint \*FAST/SAME SITE ensures neutralization to trill in homorganic (i.e., Place/stricture-sharing) clusters.

<sup>84</sup> 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* [salir<sup>l</sup>ɾapiðo] '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 [salir<sup>l</sup>ɾapiðo] as either equivalent to or distinct from one in which the word-final tap is truly absent, i.e., *salí rápido* [salilɾapiðo] '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<sup>v</sup>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 [per<sup>v</sup>ro] supplanting the latter. Consistent classification of modified [Vr<sup>v</sup>rV] tokens as contrastive with [VrV] ones would constitute evidence in favor of the claim that [Vr<sup>v</sup>rV] and [VrV] sequences are

indistinguishable, i.e., that tap + tap clusters are perceptually equivalent to single alveolar trills.<sup>85</sup>

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<sup>85</sup> 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<sub>1</sub> 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: *bead* [bi:d] versus *beat* [bit] (see Keating 1984).