

# The Role of Contrast in Laryngeal Cooccurrence Restrictions

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## 1. Introduction<sup>1</sup>

The central proposal in this paper is that laryngeal cooccurrence restrictions are restrictions on contrasts between forms in a language, not restrictions on isolated forms or structures. Combinations of laryngeal features are only marked with respect to what other combinations of laryngeal features they contrast with.

The analysis hinges on the hypothesis that the two types of laryngeal contrasts in (1) do not have the same perceptual strength.

- (1) a. 1 v 2:  $k'api \vee k'ap'i$   
b. 1 v 0 or 2 v 0:  $k'api \vee kapi$  or  $k'ap'i \vee kapi$

Crucially, the contrast between one and two instances of a laryngeal feature (1a) is hypothesized to be weaker than the contrast between the existence v. absence of a laryngeal feature in the string (1b), and thus more prone to neutralization.

## 2. The phenomenon

Many languages with ejectives, aspirates and implosives restrict the distribution of these segments. I adopt the working definition of laryngeal cooccurrence restriction in (2) to refer to a specific type of restriction on this class of sounds.

(2) Laryngeal cooccurrence restriction

The laryngeal features of one consonant in a word are restricted/determined by the laryngeal features of another, non-adjacent consonant in the root.

Cooccurrence restrictions are most often static generalizations about roots, there are usually no supporting alternations.

### 2.1. Three types of laryngeal cooccurrence restrictions

Laryngeal cooccurrence restrictions come in three types, which I will refer to as dissimilatory, assimilatory and mixed. In dissimilatory restrictions, two stops in a root may not share the same laryngeal feature. The data in (3), taken from MacEachern (1999), illustrate dissimilatory restrictions on ejectives and aspirates.

- (3) a. Shuswap - no two ejectives  $\checkmark k'p$   $*k'p'$   
s-k'lep 'coyote'  $*s-k'lep'$

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- b. Souletin Basque - no two aspirates      ✓ k<sup>h</sup>-p      \*k<sup>h</sup>-p<sup>h</sup>  
 t<sup>h</sup>ipil    ‘nude’      \*t<sup>h</sup>ip<sup>h</sup>il

Assimilatory restrictions are exactly the opposite of dissimilatory restrictions. Two stops in a root *must* have the same laryngeal feature. Aspirates and ejectives may not cooccur with plain stops.

- (4) a. Chaha (Rose and Walker 2004)      ✓ k’-p’      \*k’-p  
 ji-t’ək’ir    ‘he hides’      \*ji-t’əkir
- b. Zulu (Hansson 2001, citing Khumalo 1987)      ✓ k<sup>h</sup>-p<sup>h</sup>      \*k<sup>h</sup>-p  
 ukú-k<sup>h</sup>et<sup>h</sup>a    ‘to choose’      \*ukú-k<sup>h</sup>eta
- c. Kalabari Ijo (Hansson 2001, citing Jenewari 1989)      ✓ ɓ-d      \*ɓ-d  
 dábá    ‘lake’      \*dábá

The third type of restriction, mixed restrictions, shows a combination of dissimilation and assimilation. Stops that are otherwise identical assimilate in laryngeal features. All other pairs of stops dissimilate.

- (5) a. Chol (Coon and Gallagher 2007)  
 tʃ’ip    ‘to open’      \*tʃ’ip’      ✓ k’-p      \*k’-p’  
 k’ok’    ‘health’      \*k’ok      ✓ k’-k’      \*k’-k
- b. ‘Peruvian’ Aymara (MacEachern 1999)  
 k<sup>h</sup>api    ‘strong, skillful’      \*k<sup>h</sup>ap<sup>h</sup>i      ✓ k<sup>h</sup>-p      \*k<sup>h</sup>-p<sup>h</sup>  
 p<sup>h</sup>usp<sup>h</sup>u    ‘boiled beans’      \*p<sup>h</sup>uspu      ✓ k<sup>h</sup>-k<sup>h</sup>      \*k<sup>h</sup>-k

## 2.2. A unified analysis – contrast neutralization

It is possible to analyze assimilatory and dissimilatory restrictions with standard markedness constraints. If this type of analysis is adopted, two antagonistic markedness constraints are needed. Since precisely the configuration of laryngeal features that is prohibited in one type of language is demanded in the other, markedness constraints must exist which favor both assimilation and dissimilation in laryngeal features. While an analysis with standard markedness is possible, such an account presumes no connection between assimilatory and dissimilatory phenomena, and, moreover, makes an analysis of mixed languages particularly challenging.

I pursue a different analysis and argue that all three types of restrictions are variants of the same phenomenon driven by a single markedness constraint on *contrasts*. The relevant constraint is one that prohibits the contrast between forms with one and two instances of a laryngeal feature (\*k’-p’ v k’-p), in favor of forms that contrast the presence and absence of a laryngeal feature (either k’-p v k-p or k’-p’ v k-p). All three types of restrictions are the same in that they neutralize this 1 v 2 contrast. They differ only in the outcome of this neutralization.

Particularly striking support for this line of analysis comes from looking at mixed restrictions. To make the argument, I compare mixed restrictions to assimilatory restrictions using data from MacEachern’s 1999 survey. The argument could be made just as well by comparing mixed restrictions with dissimilatory restrictions.

Languages with mixed restrictions differ from dissimilatory languages in allowing *identical* pairs of consonants with the same laryngeal features. The contrast is shown in (6) using ejectives.

- (6)      mixed restrictions      \*k’-p’      ✓ k’-k’  
           dissimilatory restrictions      \*k’-p’      \*k’-k’

There is another importance difference between these two types of restrictions, however. Languages that allow identical consonants with the same laryngeal feature to cooccur (✓ k’-k’) systematically disallow pairs of consonants that contrast only for that feature (\*k’-k). Similarly, languages that don’t



There are two markedness constraints, one that penalizes agreement in laryngeal features, call it OCP-lar, and one that penalizing disagreement in laryngeal features in otherwise identical consonants, call it \*T'-T. Mixed languages might then arise when \*T'-T outranks the OCP. A violation of the OCP is violated only to avoid a worse violation of \*T'-T. A partial analysis, showing the interaction of these two markedness constraints, is given in (12).

(12)	/k'-k'/	*T'-T	OCP-lar
	→ k'-k'		*
	k'-k	* !	

The ranking in (12) accounts for the fact that identical ejectives are preferred over pairs of consonants that differ only in ejection. This analysis encounters a problem, however, when it is integrated with faithfulness constraints. Since non-identical consonants sharing the same laryngeal feature are ungrammatical in mixed restriction languages, OCP-lar must outrank IDENT[lar].

(13)	/k'-p'/	OCP-lar	IDENT[lar]
	→ k'-p		*
	k'-p'	* !	

The ranking \*T'-T over OCP-lar prefers [k'-k'] to [k'-k], as shown in (12). Given the ranking in (13), however, there is an even better candidate.

(14)	/k'-k'/	*T'-T	OCP-lar	IDENT[lar]
	k'-k'		* !	
	k'-k	* !		*
	→ k-k			**

No ranking of the three constraints in (14) can account for mixed cooccurrence restrictions. Moreover, the ranking in (14) predicts a potentially unattested language where pairs of consonants like [k'-k'] and [k'-k] are both ungrammatical (as in 11a). The ranking in (15a) can account for dissimilatory restrictions, but the two possible rankings in (15b) correspond to languages like (11a).

- (14) a. dissimilatory languages  
**OCP >> IDENT[lar] >> \*T'-T**  
 /k'-p'/ → [k'-p]     /k'-k'/ → [k'-k]     /k'-k/ → [k'-k]
- b. unknown languages  
**OCP >> \*T'-T >> IDENT[lar]**  
 /k'-p'/ → [k'-p]     /k'-k'/ → [k-k]     /k'-k/ → [k-k]  
**\*T'-T >> OCP >> IDENT[lar]**  
 /k'-p'/ → [k'-p]     /k'-k'/ → [k-k]     /k'-k/ → [k-k]

## 4. Markedness and laryngeal contrasts

### 4.1. Two types of laryngeal contrasts

The challenge for an analysis of mixed restrictions pointed out in (14) is to block perfect satisfaction of both markedness constraints through deletion of all input laryngeal features. The proposal here is that the relevant markedness constraints penalize laryngeal contrasts, not isolated structures. I recognize two types of laryngeal contrasts.

- (16) a. some v no (ejectives)     **k'-k'/k'-k v k-k**     **k'-p'/k'-p v k-p**  
 b. one v two (ejectives)     **k'-k' v k'-k**     **k'-p' v k'-p**

Given these two types of laryngeal contrasts, a unified understanding of all three types of restrictions is possible. All types of languages neutralize the contrast in (16b), and all maintain the contrast in (16a). Languages differ in the outcome of neutralization. Dissimilatory languages neutralize to a form with one ejective ( $k^{\prime}$ -p,  $k^{\prime}$ -k), while assimilatory languages neutralize to a form with two ( $k^{\prime}$ -p',  $k^{\prime}$ -k'). In mixed languages, pairs of non-identical stops are neutralized to a form with one ejective ( $k^{\prime}$ -p) while pairs of identical stops are neutralized to a form with two ( $k^{\prime}$ -k').

In all three types of languages, the potential three way contrast between pairs of stops differing only in the presence and absence of laryngeal features is always realized as a two way contrast. The underlying laryngeal contrast is never completely neutralized.

- (17) a.  $/k^{\prime}$ - $k^{\prime}$ /  
 $/k^{\prime}$ - $k$ /  
 $/k$ - $k$ /  
 $\rightarrow$   $k^{\prime}$ - $k^{\prime}$  v  $k$ - $k$  or  $k^{\prime}$ - $k$  v  $k$ - $k$  never just  $k$ - $k$
- b.  $/k^{\prime}$ - $p^{\prime}$ /  
 $/k^{\prime}$ - $p$ /  
 $/k$ - $p$ /  
 $\rightarrow$   $k^{\prime}$ - $p^{\prime}$  v  $k$ - $p$  or  $k^{\prime}$ - $p$  v  $k$ - $p$  never just  $k$ - $p$

#### 4.2. Contrast markedness and perceptual distinctiveness

The common factor between the cooccurrence phenomena is neutralization of the contrast between one and two instances of a laryngeal feature, but preservation of the contrast between some and no instances of a laryngeal feature. Why do languages treat these two types of contrasts differently? I propose the hypothesis in (18).

- (18) Hypothesis: The contrast between words with 1 v 2 ejectives is weaker than the contrast between words with 1 v 0 or 2 v 0 ejectives, e.g.  $k^{\prime}$ *api*- $k^{\prime}$ *ap'i* is weaker than  $k^{\prime}$ *api*- $k$ *api*.

This hypothesis is easily testable, though it is currently only speculative. If the hypothesis is correct, subjects should perform better on a discrimination task when presented with a pair of words that exhibit a 1 v 0 or 2 v 0 laryngeal contrast than when presented with a pair of words showing a 1 v 2 laryngeal contrast. For example, the pair  $k^{\prime}$ *api*- $k^{\prime}$ *api* should be more easily distinguished than  $k^{\prime}$ *api*- $k^{\prime}$ *ap'i*.

### 5. An analysis in Dispersion Theory

In this section, I propose an analysis of cooccurrence restrictions in Dispersion Theory (DT) (Flemming 1995, 2004, 2006). The core idea behind DT is that phonological contrasts are subject to the three interacting functional goals in (19) (taken from Flemming 2004).

- (19) Elements of DT
- i. Maximize the distinctiveness of contrasts
  - ii. Maximize the number of contrasts
  - iii. Minimize articulatory effort

#### 5.1. The constraints

In DT, markedness constraints favor more perceptible contrasts over less perceptible contrasts. Weaker contrasts are more marked, and thus more likely to be neutralized. If the hypothesis is correct, laryngeal contrasts are more marked in the context of another laryngeally marked consonant than in the context of other plain consonants. Consequently, some markedness constraint penalizes the contrast between 1 v 2 instances of a laryngeal feature.

Formally, cooccurrence restrictions are not driven by markedness constraints that penalize a form with one or two ejectives (like the OCP or a harmony constraint), but rather by a constraint that penalizes the contrast between these two types of forms. A constraint of this type is given in (20).

(20) LARYNGEALDISTANCE Forms with 1 and 2 instances of a laryngeal feature do not contrast.

The constraint in (20) is systemic. It does not evaluate individual forms in a language, rather it evaluates the contrasts in a set of minimally differing forms. A challenge for DT analyses is to define a comparison set. I don't address this question here, but see Ní Chiosain and Padgett (to appear) for discussion. Here, I compare sets of forms differing only in the presence v absence of a laryngeal feature. The tableau in (21) gives an example of how the constraint in (20) is evaluated.

(21)	/k <sup>ʔ</sup> -k <sup>ʔ</sup> k <sup>ʔ</sup> -k/	LARDIST
	k <sup>ʔ</sup> -k <sup>ʔ</sup> k <sup>ʔ</sup> -k	*
	k <sup>ʔ</sup> -k <sup>ʔ</sup>	✓
	k <sup>ʔ</sup> -k	✓

LARYNGEALDISTANCE interacts with the conflicting constraint, \*MERGE (Padgett 2003), which penalizes contrast neutralization.

(22) \*MERGE No output word has multiple input correspondents.

Like LARYNGEALDISTANCE, \*MERGE is a systemic constraint which evaluates sets of forms. \*MERGE has the complementary violation profile as LARYNGEALDISTANCE, it penalizes mapping distinct input forms onto a single output form.

(23)	/k <sup>ʔ</sup> -k <sup>ʔ</sup> k <sup>ʔ</sup> -k/	*MERGE
	k <sup>ʔ</sup> -k <sup>ʔ</sup> k <sup>ʔ</sup> -k	✓
	k <sup>ʔ</sup> -k <sup>ʔ</sup>	*
	k <sup>ʔ</sup> -k	*

The two conflicting constraints on contrast, LARDIST and \*MERGE, interact with contrast independent markedness constraints. While LARDIST and \*MERGE determine what and how many constraints are neutralized in a language, contrast independent markedness constraints determine the outcome of neutralization. The three constraints in (24) are needed to account for laryngeal cooccurrence restrictions.

(24) \*ejective Don't have ejectives.  
 HARMONY Stops in a word have the same laryngeal feature.  
 \*T<sup>ʔ</sup>-T Stops that differ in only a laryngeal feature do not cooccur.

The constraint \*ejective is functionally motivated, and is in keeping with the original conception of DT. Ejectives are avoided because they require distinct glottal gestures (constriction and raising) that must be coordinated with the oral constriction. An output with fewer ejectives is preferred to one with more ejectives in order to minimize articulatory effort. Similar constraints can be invoked for restrictions on aspirates and implosives. The other constraints, HARMONY and \*T<sup>ʔ</sup>-T, do not have an obvious functional motivation. Understanding why forms with two ejectives may be preferred to forms with one ejective is a topic for future research.

### 5.2. The analysis of cooccurrence restrictions

The two systemic and three classic markedness constraints in the previous section interact to account for all three types of laryngeal cooccurrence restrictions. All three types of restrictions neutralize the contrast between one and two instances of a laryngeal feature, and preserve the contrast between some v no instances of a laryngeal feature. This pattern is achieved by the following ranking of constraints, which all three languages share.

(25) LARDIST >> \*MERGE >> \*ejective, HARMONY, \*T<sup>ʔ</sup>-T

The ranking LARDIST >> \*MERGE forces neutralization of the 1 v 2 contrast. The ranking of \*MERGE over the classic markedness constraints forces preservation of 1 v 0 or 2 v 0 contrast.

The outcome of neutralization varies from language to language depending on the ranking of the contrast independent markedness constraints. In dissimilatory languages, \*ejective outranks the two harmony constraints HARMONY and \*T'-T

(26) Dissimilatory languages – LARDIST >> \*MERGE >> \*ejective >> HARMONY, \*T'-T

a.	/k'-p' k'-p k-p/	LARDIST	*MERGE	*ejective	HARMONY	*T'-T
	k'-p' k'-p k-p	* !			*	
	k'-p' k'-p	* !	*	*** !	*	
	k'-p' k-p		*	** !		
	→ k'-p k-p		*	*	*	
	k-p		** !			

  

b.	/k'-k' k'-k k-k/	LARDIST	*MERGE	*ejective	HARMONY	*T'-T
	k'-k' k'-k k-k	* !			*	*
	k'-k' k'-k	* !	*	*** !	*	*
	k'-k' k-k		*	** !		
	→ k'-k k-k		*	*	*	*
	k-k		** !			

In assimilatory languages, Harmony is the highest ranked of the contrast free markedness constraints. Forms with two ejectives are always preferred to forms with one.

(27) Assimilatory languages – LARDIST >> \*MERGE >> HARMONY >> \*ejective, \*T'-T

a.	/k'-p' k'-p k-p/	LARDIST	*MERGE	HARMONY	*ejective	*T'-T
	k'-p' k'-p k-p	* !		*		
	k'-p' k'-p	* !	*	*	***	
	→ k'-p' k-p		*		**	
	k'-p k-p		*	* !	*	
	k-p		** !			

  

b.	/k'-k' k'-k k-k/	LARDIST	*MERGE	HARMONY	*ejective	*T'-T
	k'-k' k'-k k-k	* !		*		*
	k'-k' k'-k	* !	*	*	***	*
	→ k'-k' k-k		*		**	
	k'-k k-k		*	* !	*	*
	k-k		** !			

In mixed languages, there are two crucial rankings. \*T'-T outranks \*ejective, forcing harmony between pairs of otherwise identical stops. \*Ejective, however, outranks the general HARMONY constraints, and prefers dissimilation between heterorganic pairs of consonants.

(28) Mixed languages – LARDIST >> \*MERGE >> \*T'-T >> \*ejective >> HARMONY

a.	/k'-p' k'-p k-p/	LARDIST	*MERGE	*T'-T	*ejective	HARMONY
	k'-p' k'-p k-p	* !			***	*
	k'-p' k'-p	* !	*		***	*
	k'-p' k-p		*		** !	
	→ k'-p k-p		*		*	*
	k-p		** !			

b. /k'-k' k'-k k-k/	LARDIST	*MERGE	*T'-T	*ejective	HARMONY
k'-k' k'-k k-k	* !			***	*
k'-k' k'-k	* !	*	*	***	*
→ k'-k' k-k		*		**	
k'-k k-k		*	* !	*	*
k-k		** !			

## 6. Conclusion and discussion

In this paper, I have shown that the unifying factor between three different types of laryngeal cooccurrence restrictions is the neutralization of one laryngeal contrast and preservation of another. Dissimilatory, assimilatory and mixed languages all neutralize the contrast between one and two instances of a laryngeal feature, and preserve the contrast between some and no instances of a laryngeal feature. Looking at the data from this perspective allows all three phenomena to be analyzed uniformly, unlike in previous analyses (MacEachern 1999; Hansson 2001; Rose and Walker 2004).

I have hypothesized that there is a perceptual motivation for the grammatical distinction between the two types of laryngeal contrasts: an ejective and a plain stop are less perceptually distinct in a word with another ejective than in a word with only other plain consonants. The hypothesis is that pairs of words that show a 1 v 2 contrast, like *k'api-k'ap'i*, are harder to distinguish than pairs of words that show a 1 v 0 contrast, like *k'api-kapi*. The analysis is cast in Dispersion Theory, which formalizes the idea that less perceptible contrasts are more prone to neutralization than stronger contrasts.

There are two major remaining issues. The first is the source of the distinction between the 1 v 2 and 1 v 0 contrasts. If it turns out that these two types of contrast do differ in perceptual strength, why? What acoustic or other property makes one contrast better than the other? Second, the functional motivation for harmony between consonants needs to be explored in much greater detail. It is not clear why forms with two ejectives should be preferred to forms with one ejective, which are articulatorily easier. In mixed languages, heterorganic and homorganic consonants behave differently with respect to harmony. It is also not clear why this split should exist.

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