Near-identity and laryngeal harmony*

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SUMMARY

This paper presents analyses of consonant harmony in laryngeal features in Ngizim, Hausa and Tzutujil. Consonant harmony processes have figured prominently in theoretical work on the significance of similarity in the phonological grammar (e.g. Hansson, 2001, 2010; Rose and Walker, 2004). The cases analyzed in this paper provide evidence that two definitions of similarity are necessary to account for the observed variation in harmony patterning. In Ngizim, segments which participate in harmony are similar in that they share a natural class. In Hausa and Tzutujil, participating segments are near-identical, defined as differing in only a single feature. In both the natural class case and the near-identity cases, similarity is evaluated over contrastive feature specifications with the contrastive status of a given feature determined by a hierarchic ordering of binary divisions (Dresher, Piggott, and Rice, 1994; Dresher 2003, 2009).

1 INTRODUCTION

Typological studies of consonant harmony have demonstrated that segments which interact as targets and triggers of consonant harmony processes are highly similar to one another (e.g. Hansson, 2001, 2010; Rose and Walker, 2004). This paper argues that two notions of similarity are relevant for determining interacting segments in consonant harmony processes, namely natural classes and near-identity. Three cases of consonant harmony in laryngeal features are considered. In Ngizim, the natural class of segments specified for the harmonic feature interact in [voice] harmony. In Hausa and Tzutujil, harmony results in total, segmental identity. Segments which interact in these cases are near-identical, defined as differing in only a single feature specification.

This paper further argues that both natural classes and near-identity are determined with reference to contrastive feature specifications. The theoretical model of contrast adopted and argued for here is that of the contrastive hierarchy (Dresher, Piggott, and Rice 1994; Dresher 2003, 2004, 2009; Hall 2007). In this theory, the contrastive status of feature specifications is

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determined by a series of binary splits consistent with an ordered hierarchy of features. According to this approach, segmental representations, and any evaluation of similarity or near-identity based on them, are influenced by both inventory shape and the ordering of features in the contrastive hierarchy.

2 CONTRAST

In determining which features are contrastive, I adopt the theory of the contrastive hierarchy in which contrasts are determined by hierarchic ordering of features with some features taking scope over others. The idea that contrastive specifications depend on a series of ordered, binary divisions has been developed in work by Dresher, Piggott, and Rice (1994) and Dresher (2003, 2004, 2009) and has roots in early generative phonology (e.g., Jakobson and Halle, 1956). With this approach, the feature specifications of a given segment will depend both on the inventory of the language in question, and on the hierarchy of features.

Features are assigned according to the Successive Division Algorithm (SDA).

(1) Successive Division Algorithm (informal version, Dresher, 2004)
   a. Begin with *no* feature specifications: assume all sounds are allophones of a single undifferentiated phoneme.
   b. If the primordial allophonic soup is found to consist of more than one contrasting member, select a feature and divide the set into as many subsets as the feature allows for.
   c. Repeat step (b) in each subset: keep dividing up the inventory into sets, applying successive features in turn, until every set has only one member.

According to the theory of the contrastive hierarchy, the feature selected first in the hierarchy will be contrastive for the entire inventory. Features lower down in the hierarchy will be contrastive only for those segments which still require the feature in question in order to be uniquely specified.

3 LARYNGEAL HARMONY AND NATURAL CLASSES: NGIZIM

Ngizim is a Chadic language with a restriction barring voiced and voiceless obstruents from cooccurring (Schuh, 1971,1997; Hansson 2001, 2004, 2010.)[1]

(2)

gâ:zá	‘chicken’	*k…z (Schuh, 1997)
dəbâ	‘woven tray’	*t…b
zə̀dù	‘six’	*s…d
kùtə́r	‘tail’	
tàsáu	‘find’	

Although voiced, implosives do not participate in the restriction and occur freely with voiceless stops.

[1] Restrictions on the cooccurrence of voiced and voiceless segments in Ngizim are directional. Voiceless obstruents are not followed by voiced obstruents but forms with voiced obstruents followed by voiceless ones do occur (e.g., bàkú ‘roast’). I do not account for directionality effects here.

(3) kì:ɗú ‘eat (meat)’ (Schuh, 1997)
pəɗək ‘morning’

The Ngizim consonant inventory is given below.

Table 1: Ngizim obstruent inventory (based on Schuh, 1971)[2]

p	t	tʃ		k	k^w
b	d	dʒ		g	g^w
ɓ	ɗ	$ɗ^j$			
f	s	ʃ	ɬ		
v	z	ʒ	ɮ		

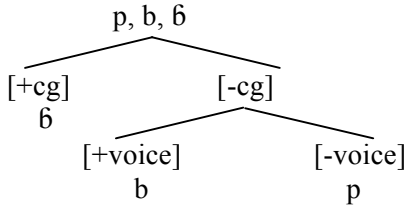
An intuitive appeal to contrast can be made on the basis of a cursory inspection of the Ngizim inventory. For any given place of articulation, stops and fricatives, which participate in harmony, have partners that differ only in voicing, whereas implosives, which fail to participate in harmony, do not. If we assume that only contrastive features are active in phonological processes (see Hall 2007 for discussion of this ‘contrastivist hypothesis’) the neutrality of implosives can be accounted for by the fact that they are not contrastively specified in the harmonic feature. The connection between inventory shape and phonological activity has motivated work in earlier theories of underspecification (e.g. Kiparsky, 1982; Archangeli 1984; Steriade 1987). In the case of Ngizim, Hansson (2001, 2010) also observes a connection between the lack of a voicing contrast among implosives and their neutrality with respect to [voice] harmony.

The theory of the contrastive hierarchy differs from previous approaches in providing an explicit method of determining which features are contrastive for which segments, namely the SDA. According to the theory of the contrastive hierarchy, determining the contrastive specifications of a given segment depends not only on the inventory, but also on the hierarchy of features. The lack of a voicing contrast among implosives in Ngizim does not require that implosives be unspecified for voice. This result also depends upon the feature [constricted glottis] being ordered above the feature [voice].

The SDA is illustrated below using a subset of the Ngizim consonant inventory. Within the set of labial stops, Ngizim has a three-way laryngeal contrast between voiced, voiceless and implosive. Two laryngeal features will be needed in order for each labial stop to be uniquely specified. The tree below shows the application of the SDA with the feature [constricted glottis] ordered above the feature [voice].

[2] Schuh (1971) also includes a glottal fricative and lateral and rhotic approximants which he identifies as occurring in foreign vocabulary items only. A series of prenasalized stops are also identified as occurring only in foreign items and are further restricted in that they occur only word-initially in foreign forms.

(4) Contrastive hierarchy: [constricted glottis] > [voice]



In the hierarchy shown above, the feature [constricted glottis] is assigned first and all segments in the set are specified as [+constricted glottis] or [-constricted glottis]. /ɓ/ is the only [+constricted glottis] segment in the set and hence is uniquely specified once this feature is added. The feature [voice] is added next and is only contrastive within the [-constricted glottis] set. /p/ and /b/ are assigned the features [-voice] and [+voice], respectively. At this point, each member of the set is uniquely specified.

The resulting specifications for the labial stops are shown in (5).

(5) Laryngeal specifications for labial stops

p	b	ɓ
[-cg]	[-cg]	[+cg]
[-voice]	[+voice]	

The set of segments which participate in harmony in Ngizim can be characterized as the natural class of segments contrastively specified for [voice], the harmonic feature. Implosives are excluded from this class, and fail to participate in harmony, because they are not contrastively specified for [voice]. If this account is correct, we expect implosives to fail to pattern with [+voice] segments, not only in laryngeal harmony, but also in other phonological processes. Support for this position can be found in the patterning of implosives in a variety of phonological processes.

In Ngizim, word-medial obstruent clusters must agree in voicing (Schuh, 1997). Some examples of words with well-formed obstruent clusters are given in (6) below.

(6)

akʃi	‘they, them’ (Bedu, Yakubu, Adamu, and Garba, 2004)
àskàràbu	‘soldier’
bəgɮu	‘bubble’

Implosives are not subject to this restriction and can occur with preceding or following voiced or voiceless obstruents.

(7)

dùkɗu	‘grunt, strain’ (Bedu et al., 2004)
dɛ̀dku	‘peek, peer into’
gaɓdàmak	‘rebellious, cocky’

Voicing assimilation is also visible in active alternations across word boundaries. The data in (8) show that implosives fail to trigger voicing assimilation.

(8) áa kùnú-k dàa ‘in the town’ (Schuh, 1971)
áa kùnú-g dùuníyà ‘in the world’

Finally, implosives fail to pattern with voiced obstruents in consonant tone interactions. High tone spreads across voiceless obstruents, sonorants and implosives (9a) but spreading is blocked by voiced obstruents (9b).

(9) a. /ná kàtàu/ > ná kátáú ‘I returned’ (Tang, 2008)
/ná màsú/ > ná mású ‘I bought’
/ná ɓədú/ > ná ɓədú ‘I pinched’
b. /ná dʒəbú/ > ná dʒəbú ‘I caught’
/ná zàdáú/ > ná zàdáú ‘I arrived’

In summary, the fact that stops and fricatives minimally contrast in voicing requires that these segments be contrastively specified for [voice]. With a hierarchy of features in which [constricted glottis] is ordered above [voice], the implosives are not contrastively specified for [voice]. Given these representations, we can delimit the class of segments which participate in harmony as the natural class of segments contrastively specified for the feature [voice]. This proposal is consistent with the behavior of implosives with respect to other phonological processes.

4 LARYNGEAL HARMONY AND NEAR-IDENTITY

In Ngizim, segments which interact in [voice] harmony constitute the natural class of segments contrastively specified in the harmonic feature. In other cases of laryngeal harmony, however, interacting segments must not only be specified for the harmonic feature, but must also share major place of articulation. In these cases, harmony results in total identity between target and trigger. Hausa and Tzutujil provide examples of laryngeal harmony processes which cannot be described as taking place between all segments contrastively specified in the harmonic feature. I propose that, in these cases, interacting segments are near-identical. They differ in only a single contrastive feature specification.

4.1 HAUSA

Hausa, like Ngizim, is a Chadic language with restrictions affecting the distribution of laryngeal features. In Hausa, laryngeal harmony is realized as cooccurrence restrictions affecting glottalized consonants (Newman, 2000; Hansson, 2001, 2010; MacEachern, 1999).

The Hausa obstruent inventory is shown below.

Table 2: Hausa obstruent inventory (Newman, 2000)[3]

f, f^j	t	tʃ	k	k^w	k^j	
b	d	dʒ	g	g^w	g^j	
ɓ	ɗ		k’	k^w’	k^j’	ʔ
	s	ʃ				h
	z					
	s’					

The inventory above shows that the glottalized series is not uniform. Hausa has a series of glottalized stops which is implosive at the labial and coronal places of articulation and ejective at the velar place of articulation. Differences in the laryngeal properties of stops across different places of articulation are common and have a functional, phonetic motivation (see e.g. Lisker and Abramson, 1964, Benki, 2001). With respect to glottalized stops, ejectives involve the creation of a high pressure area in the supraglottal chamber by closing the vocal folds and raising the larynx while a closure is maintained farther forward in the vocal tract. The creation and maintenance of high air pressure in the supraglottal chamber is more difficult with anterior places of articulation. The supraglottal chamber of labials and coronals is larger than that of other stops leading to a weaker compressive effect when the larynx is raised. For these reasons, labial and coronal ejectives are disfavoured relative to more posterior stops such as palatals and velars.

The data in (10a) show that multiple non-identical glottalized segments may not co-occur. Identical glottalized segments are exempt from this restriction as illustrated in (10b).

(10) a. *ɓak’a
*s’aɓa
*k’aɗa

b. ɓaɓe ‘quarrel’ (from Newman, 2000, tones omitted)
s’as’a ‘rust’
k’ukuta ‘try hard’

An additional constraint bars the co-occurrence of glottalized segments and their homorganic, non-glottalized counterparts (11).[4]

(11) *ɓaba
*s’asa
*ɗadi
*k’aka

[3] In Hausa, there is no phonemic contrast between /f/ and /p/. I am treating /f/ phonologically as the voiceless counterpart of /b/ and include it in the chart along with the voiceless stops (following Newman, 2000). Newman (2000) also includes a glottalized palatal glide, /j’/. This phoneme is a recent innovation that occurs in very few lexical items. The following discussion of restrictions on glottalized segments does not consider the behaviour of /j’/.

[4] In the alveolar series, there is a directionality effect such that /ɗ/ followed by /d/ and /s’/ followed by /s/ are unattested whereas the reverse is found in some forms (e.g. daaɗɪɪ ‘pleasantness’, daɗe ‘last long’, sans’ɪ ‘slipperiness’). Restrictions affecting the other place series are bidirectional. I do not account for the directionality effects here.

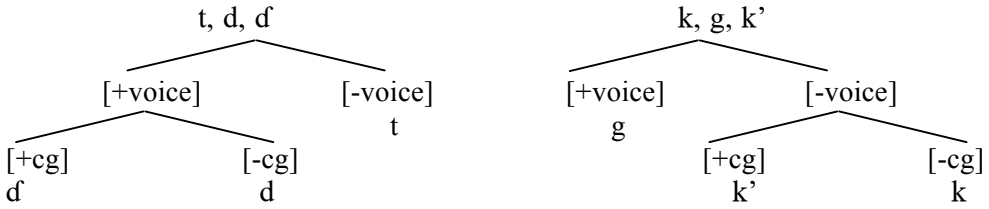
Following previous work (Hansson, 2001, 2010; Rose and Walker, 2004), I analyze this pattern as consonant harmony in the feature [constricted glottis] which is parasitic on place of articulation. Only homorganic segments interact as targets and triggers of [constricted glottis] harmony. However, homorganic segments differing in both [voice] and [constricted glottis] co-occur freely, as shown in (12).

(12)	ɗata	'a small, bitter, green tomato'
	taɗa	'chat, converse'
	gak'e	'hem in, prevent movement'
	k'ugu	'pelvis'

The fact that ejectives cannot occur with homorganic voiceless stops and that implosives may not occur with homorganic voiced stops suggests that the voicing difference among the glottalized segments is present in the phonological representations and is not simply a matter of phonetic implementation. This can be achieved if we order the feature [voice] over the feature [constricted glottis] in a contrastive hierarchy.

The following diagrams illustrate the application of the SDA to a subset of the Hausa inventory. Specifications for the set of velar stops and coronal stops are shown.

(13) Contrastive hierarchy: [voice] > [constricted glottis]



The tree diagrams above assume that the set of coronal stops and the set of velar stops are distinguished from other segments by higher ordered features referring to place and manner of articulation. With respect to laryngeal features, the feature [voice] is assigned first. In the coronals, the /t/ is the only voiceless member of the set. Once the feature [voice] is assigned, the /t/ is uniquely specified and does not acquire further contrastive specifications. The /d/ and /ɗ/ are both [+voice] and are distinguished from one another by specifications as [-constricted glottis] and [+constricted glottis], respectively. In the velar set, /g/ is the only voiced segment and it is uniquely specified when the feature [voice] is assigned. The feature [constricted glottis] is assigned to the voiceless velars in order to differentiate /k/ and /k'/.

The laryngeal specifications for the segments shown above, given the proposed feature ordering, are shown in (14).

(14)	t	d	ɗ	k	g	k'
	[-voice]	[+voice]	[+voice]	[-voice]	[+voice]	[-voice]
		[-cg]	[+cg]	[-cg]		[+cg]

Given the specifications above, segments which interact in [constricted glottis] harmony in Hausa are those segments which differ only in their specification for the harmonic feature. Laryngeal harmony in Hausa can be characterized as harmony in the feature [constricted

glottis] which is active between near-identical segments. Interacting segments differ in only a single, contrastive feature specification. The result of harmony is total segmental identity.

Note that this analysis crucially relies on [voice] being ordered above [constricted glottis] in the feature hierarchy. If the feature [constricted glottis] were ordered above [voice], the glottalized stop for each place of articulation would be uniquely specified before the feature [voice] is assigned. Implosives and ejectives would not be specified for [voice] in this scenario, and would be expected to pattern alike with respect to [constricted glottis] harmony. The relative order of laryngeal features in the hierarchy of Hausa is the reverse of the order argued for in the analysis of Ngizim. Ngizim and Hausa differ from one another in the threshold of similarity needed for segments to interact in harmony. In Ngizim, all segments contrastively specified for the harmonic feature interact in [voice] harmony whereas [constricted glottis] harmony in Hausa is active only between near-identical segments which differ only in their specification for the harmonic feature. Ngizim and Hausa also differ from one another with respect to the relative order of [voice] and [constricted glottis] in the feature hierarchy.

4.2 TZUTUJIL

Tzutujil (Mayan) has a system of laryngeal harmony realized as co-occurrence constraints on the distribution of glottalized consonants (Dayley, 1985; Hansson, 2001, 2010; MacEachern, 1999).

The Tzutujil obstruent inventory is shown below.

Table 3: Tzutujil consonant inventory (based on Dayley, 1985)

p	t	ts	tʃ	k	q	
ɓ	ɗ	ts’	tʃ’	k’	q’	ʔ
		s	ʃ		χ	h

As in Hausa, the glottalized series is not uniform in Tzutujil. The labial and alveolar glottalized stops are implosives whereas the velars, uvulars and affricates are ejective.

MacEachern (1999) describes the constraints illustrated in the following data. Multiple, non-identical ejectives may not co-occur in Tzutujil (15a). Identical ejectives are exempt from this restriction (15b).[5]

(15) a. *tʃ’iiq’
*k’its’
*q’uk’

b. tʃ’iitʃ’ ‘metal’ (MacEachern, 1999)
q’iiq’ ‘north wind’

Ejectives may not co-occur with their homorganic, plain counterparts.

[5] The fact that ejectives participate in the restriction against multiple glottalized segments and that implosives fail to participate in this restriction is robustly supported by the data. The data on the restriction against homorganic plain/glottalized pairs is less clear. I assume the constraints are as described in MacEachern (1999) but acknowledge that more data is needed.

(16) *k'ik
*qiiq'
*ts'uts

The restrictions in Tzutujil are similar to those in Hausa. The fact that ejectives participate in the co-occurrence constraints, to the exclusion of implosives, suggests that, as in Hausa, voicing is phonologically specified in the implosives and plays a role in determining the patterning of laryngeal harmony. The structure of the phonemic inventory, however, differs between the two languages. Tzutujil has only a two-way laryngeal contrast for each place of articulation. If place features are ordered above laryngeal features in a contrastive hierarchy, only a single laryngeal feature can be contrastively specified for each place.

The following diagrams show the application of the SDA to the Tzutujil labial stops and velar stops with the feature [voice] ordered above the feature [constricted glottis].

(17) Tzutujil contrastive hierarchy, [voice] > [constricted glottis]

As in the contrastive hierarchies in previous examples, the illustration of feature ordering in Tzutujil assumes that place features are ordered above laryngeal features. After place features have been assigned, the stops are separated into homorganic pairs. At this point, the feature [voice] is assigned. In the labial set, the implosive is specified as [+voice] and the plain stop as [-voice]. Both labial stops are now uniquely specified and no other contrastive features are assigned to this set. In the velar set, the feature [voice] is not assigned because it does not further differentiate between the plain voiceless stop and the ejective. [voice] is not potentially contrastive within this set so the SDA proceeds to the next ordered feature in the hierarchy, [constricted glottis]. /k/ is specified as [-constricted glottis] and /k'/ as [+constricted glottis]. Each velar is now uniquely specified and no other features are assigned.

The resulting specifications for these segments are shown below.

(18)

p	ɓ	k	k'
[-voice]	[+voice]	[-cg]	[+cg]

The voiceless velar stop and the ejective velar stop differ only in their specification for [constricted glottis]. These segments are near-identical and they participate in [constricted glottis] harmony. The labials, however, have no specification for any value of [constricted glottis] and cannot participate in harmony.

In addition to [constricted glottis] harmony that takes place between near-identical segments, both Hausa and Tzutujil have restrictions on multiple, glottalized segments cooccurring within a morpheme. If these restrictions are bans on multiple [+constricted glottis] specifications, implosives are not expected to participate in this constraint in Tzutujil, as they are not contrastively specified for the feature [constricted glottis]. In Hausa, there is a three-way laryngeal contrast. Although the feature [voice] is ordered above the feature [constricted glottis] in both Hausa and Tzutujil, Hausa implosives are contrastively specified

for both [voice] and [constricted glottis]. Hausa implosives are therefore expected to participate in the restriction against multiple glottalized segments, just as ejectives do.

The following data illustrate the different behaviour of the implosives with respect to the ban on multiple, glottalized segments in Hausa and Tzutujil. In Hausa, implosives are barred from co-occurring and from occurring with ejectives. In Tzutujil, while forms with multiple ejectives are barred, implosives may occur with ejectives and forms with multiple implosives are permitted.

(19)	Tzutujil		Hausa
	*tʃ'iiq'		*s'ak'a
	*k'its'		*k'as'a
	ɓats'	'thread'	*ɓak'a
	huɓiɗ	'a tear'	*ɗaɓa

The analysis proposed here draws a connection between the shape of the inventory and phonological patterning. In Hausa, the greater number of laryngeal contrasts in the inventory allows [constricted glottis] to be contrastively specified on the implosives, even if they are specified as [+voice].[6]

In Tzutujil, the fact that [voice] is contrastive in the implosives and [constricted glottis] is not is somewhat unexpected. [constricted glottis] appears to be a more important feature in the system. It differentiates a greater number of phonemes and it is referred to in significant phonological generalizations like laryngeal harmony and the co-occurrence constraint against multiple ejectives. However, if place features are ordered above laryngeal features, the theory of the contrastive hierarchy predicts that different place classes may have different systems of contrast.

Evidence for the significance of place features in the structure of laryngeal distinctions is found if we look at related languages. Proto-Mayan, like Tzutujil, has a contrast between plain and glottalized stops. In Proto-Mayan, the labial is implosive and all other glottalized stops are ejective (Campbell, 1997). Many descendent languages, related to Tzutujil, have a richer set of contrast among stops only in the labial series. Modern Yucatec (Straight, 1976), Classical Yucatec (McQuown, 1967), Chol (Gallagher and Coon, 2009), and Tsotsil (Weathers, 1947) all have a voiceless /p/, an ejective /p'/ and a voiced /b/. In some of the sources, the voiced segment is described as implosive, in others it is described simply as voiced or pre-voiced. In all of these languages, a voicing contrast is not found at other places of articulation in the native vocabulary.[7]

If Proto-Mayan has a system of contrasts parallel to that proposed here for Tzutujil, the expansion of the inventory at the labial place of articulation can be thought of as filling in a gap in the inventory. It is further evidence that the contrast between labial implosives and labial voiceless stops is not exactly parallel to the contrast between ejectives and voiceless stops at other places of articulation. In the proto language, the feature [constricted glottis] was not contrastive in the labial series but was contrastive at other places. If contrastive specification for [constricted glottis] is extended into the labial series, it creates an additional,

[6] For a different approach to the analysis of Hausa and Tzutujil co-occurrence restrictions see Gallagher (2010) who argues that implosives are specified for different auditory features in Hausa and Tzutujil.

[7] Tzutujil has an implosive at the coronal as well as the labial place of articulation. This is not the case, however, in Proto-Mayan or in many other Mayan languages. This discussion therefore focuses on the contrasts in the labial series.

three-way contrast, as the feature [voice] is already contrastive among labials. Such a development could lead to the contrast between ejective, voiced, and voiceless labials seen in the Mayan languages noted above.

5 CONCLUSION

This paper has proposed two definitions of similarity relevant to determining the class of segments which participate in laryngeal harmony systems. In Ngizim, the segments that participate in [voice] harmony are similar in the sense that they constitute the natural class of segments specified for the harmonic feature. In Hausa and Tzutujil, [constricted glottis] harmony is active between segments that differ in only a single feature specification. Interacting segments are near-identical and harmony results in total segmental identity.

Both natural classes and near-identity are determined with reference to contrastive feature specifications with contrastive specifications determined in accordance with the theory of the contrastive hierarchy. In this approach, contrastive specifications are affected by both inventory shape and the order of features in the feature hierarchy. In Ngizim, the feature ordering [constricted glottis] over [voice], combined with the fact that there are no voiceless glottalized segments in the inventory, results in specifications in which the implosives are not specified for [voice]. The implosives fail to participate in [voice] harmony and also fail to pattern with voiced obstruents in a range of other phonological processes. In Hausa and Tzutujil, the reverse order of laryngeal features in the hierarchy results in implosives being specified for [voice] and leads to differences in the patterning of ejectives and implosives with respect to laryngeal harmony.

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