

# Long-distance voicing agreement: An evolutionary perspective

Gunnar Ólafur Hansson  
University of British Columbia  
(ghansson@interchange.ubc.ca)

## 1. Introduction

- Modal voicing is a property which is not associated with elongated (temporally distributed) cues in the speech signal, unlike many other features, e.g. aspiration or glottalization.
- If long-distance phonological interactions such as assimilation (“agreement”) or dissimilation generally result from listener-based sound change (Ohala 1992, 1993, 1994), then long-distance agreement in the feature [ $\pm$ voiced] is *not* expected to occur.
- Voicing agreement (voicing harmony) *does* exist, though it is quite rare (see Hansson 2001a; Rose & Walker to appear):
  - (1) Voicing alternations in affixes in Kera (East Chadic; Chad):

a. Prefix alternation [kə-]~[gə-]	b. Suffix alternation [-ka]~[-ga]
kə-kámná-w ‘chief (plur.)’	sár-ká ‘black (fem.)’
gə-dàjgá-w ‘jug (plur.)’	dʒàr-gá ‘colorful (fem.)’
  - (2) Three-way laryngeal agreement in Zulu (Bantu; S. Africa):

-k <sup>h</sup> et <sup>h</sup> a	‘to choose’
-guba	‘to dig’
-peta	‘to dig up’
- Recent work has argued that such long-distance assimilatory phenomena involve *agreement* at a distance, and have their roots in the psycholinguistic domain of speech planning (Walker 2000, 2001; Rose & Walker 2000, to appear; Hansson 2001a,b).
  - (3) Some salient characteristics of consonant agreement:
    - a. Highly sensitive to (triggered by) *similarity* of potential trigger-target pair.
    - b. Sensitive to *proximity* of target to trigger.
    - c. Displays certain asymmetries robustly attested in speech errors (anticipation vs. perseveration, “palatal bias” effects, etc.).
    - d. Very often restricted to morpheme-internal contexts, derivational (as opposed to inflectional) domains.
- Still very unclear *how* (synchronic) consonant agreement phenomena are “rooted” in the speech planning domain (synchronically and/or diachronically). What does this mean exactly?

- Evolutionary Phonology (Blevins & Garrett 1998, to appear; Blevins to appear a, b, c; Garrett & Blevins to appear): emphasis on *diachronic* mode of explanation for synchronic sound patterns.
- (4) Important questions:
- a. What are the diachronic pathways by which consonant agreement phenomena can and do arise?
  - b. Do some or all agreement systems of a particular type arise by “unnatural” mechanisms—i.e. not (listener-based) sound change but *analogical* processes?
  - c. Does a case-by-case examination of the origins of individual systems shed light on the typological properties of those systems?
  - d. Can this help sharpen our understanding of consonant agreement and its relation to factors of speech planning?
- This paper address the questions in (4) with respect to one particular subtype of consonant agreement phenomena: [voi] agreement.

- (5) Central claims:
- a. Some of the “best” examples of [voi] agreement are likely to be the secondary diachronic result of analogical processes—and thus have little or nothing to do with factors of speech planning (relative similarity, etc.)
  - b. The “unnatural” scenario helps explain certain otherwise anomalous aspects of the systems in question.
  - c. The small residue of attested cases is very “well-behaved”, showing a range of properties that are characteristic of the vast majority of consonant agreement phenomena.

## 2. Potentially “unnatural” histories of voicing agreement

- Typology of attested voicing agreement systems suggests that most cases may well have an “unnatural” diachronic origin, arising from analogical processes.
- (6) Nearly-exhaustive categories of voicing agreement systems:
- a. The language shows (synchronically and/or diachronically) extensive *tone-voicing interdependence*—in particular an interaction of L tone and [voiced] obstruents—as well as tone-spreading processes.
  - b. The language has agreement in at least one *other laryngeal feature* as well; distributional evidence may suggests voicing agreement is “modeled after” agreement in other feature.
- (7) Potential explanation for (6a) cases:  
Fortuitous identity-at-a-distance in [voi], arising through L-induced voicing (and, potentially, L-spread), is *analogically reinterpreted* as identity due to agreement.

(8) Potential explanation for (6b) cases:

Independently existing agreement in [spread glottis], [constr. glottis], etc. is *analogically extended* to encompass all laryngeal features (or Laryngeal node as such), hence including [voi].

**2.1. Analogical reanalysis of tone-voicing interaction?**

- Cross-linguistically, laryngeal features are known to interact strongly with pitch and phonological tone (e.g., Hyman & Schuh 1974; Maddieson 1974, 1976; Hombert 1978; Hombert et al. 1979).
- Modal voicing has f<sub>0</sub>-lowering effect; phonologically, [voi] often conditions L or prevents H (e.g., Peng 1992; Bradshaw 1999).

*2.1.1. Prelude: Tone can govern [voi] values*

- Tone-voicing correlation is *bidirectional*: L may induce [voi], just as [voi] may trigger/facilitate L (Maddieson 1974, 1976; Poser 1981; Bradshaw 1999).
- Clearest case of tone-induced voicing is Yabem (Austronesian, Papua New Guinea; Dempwolff 1939; Bradshaw 1979; Poser 1981; Ross 1993, 1995; Bradshaw 1999).

(9) Tone and obstruent voicing within Yabem morphemes:

a.	áwé	‘outside’	àwè	‘woman’
	ólí	‘body’	òlì	‘wages’
b.	píŋ	‘shell’	bìŋ	‘speech’
	típ	‘all at once’	dìb	‘thud’
	pálíŋ	‘careless’	bàlìŋ	‘far away’

(10) Tone/voicing alternations in verb prefixes (1Sg [ká-]~[gà-], 1PIIncl [tá-]~[dà-]):

a.	ká-táŋ	‘I weep’	b.	gà-dèŋ	‘I move towards’
	tá-táŋ	‘we weep’		dà-dèŋ	‘we move towards’

- Combination of tone spreading and tone-governed voicing gives *appearance* of long-distance [voi] agreement in obstruents (Bradshaw 1979).
- This “agreement” even *appears* to show a similarity restriction: the fricative /s/ does not participate, only the stops:

(11) No “voicing agreement” between stop and fricative:

a.	tá-sáʔ	‘we hammer’	dà-sàʔ	‘we put on top of’
b.	sé-táŋ	‘they weep’	sè-dèŋ	‘they move towards’ <sup>1</sup>
	sákíŋ	‘service’	sàgìŋ	‘house partition’

- Apparent similarity restriction results from historical devoicing of \*z across the board, obliterating previous [z]~[s] alternations (Bradshaw 1979; Ross 1993).

---

<sup>1</sup> Due to an independently-existing stricture harmony (optional in modern-day Yabem), these two 3PI forms have the variants [té-táŋ], [dè-dèŋ]; see Hansson (2001) for discussion.

## 2.1.2. Voicing agreement and L-[voi] interaction in Kera

- Only one documented case where voicing agreement results in alternations, i.e. reaches across morpheme boundaries: Kera (East Chadic, Chad; Ebert 1979a; Odden 1994; Walker 2000, 2001; Rose & Walker to appear; Hansson 2001a).
- With extremely few exceptions, voiced and voiceless pulmonic plosives do not cooccur within a word.

## (12) Voicing agreement in Kera words (Ebert 1979a):

a. dègé	‘to tramp’	b. téké	‘to pluck’
dèbé	‘to flee’	tépé	‘to gather’
dèbèrgá	‘hen’	kūpúrkí	‘billy goat’

## (13) Voicing agreement triggers alternations in nominal affixes (Ebert 1979a):

a. /k+sír+kí/	→	kīsírkí	‘black (masc.)’
/k+džír+kí/	→	gìdžìrgí	‘colourful (masc.)’
/k+džàr+káŋ/	→	gèdžàrgáŋ	‘colourful (coll.)’
b. /k+ta:tá+w/	→	kātā:táw	‘cooking pots’
/k+dàjgá+w/	→	gèdàjgáw	‘jugs’
/k+džà:ŋà+w/	→	gèdžà:ŋáw	‘footstools’

- Among obstruents in general, *implosives* (14a) as well as *fricatives* (14b) do not appear to participate in the [voi] agreement:

## (14) Implosives and fricatives neutral/immune to voicing agreement (Ebert 1979a):

a. dǐgí	‘to think’	
ǂálgé	‘to spoil’	
ǂákáj	[no gloss]	
dúpí	‘to scoop (pl.)’	
tʃérdé	‘to press’	
gùbí	‘to shut in’	
b. fèrgé	‘to itch’	(< *vèrgé)
dèfé	‘to make [sauce]’	(< *dèvé)

- Both limitations in (14) could be interpreted as reflecting a similarity restriction (Rose & Walker to appear). However, this is less than ideal:
  - The apparent failure of fricatives to trigger/undergo [voi] agreement is clearly a *secondary* result of the general devoicing of voiced fricatives (almost universal for /z/ > /s/, sporadic for /v/ > /f/). For each individual word, the original [voi] value can be inferred from the tone pattern. Once original [voi] values are “restored”, it appears that there are few if any cases of [voi] *disagreement* in words mixing plosives with fricatives. In its original form, [voi] agreement must have targeted plosives and fricatives alike.
  - Interpreting implosives as consistently dissimilar to pulmonic obstruents creates severe problems with respect to the similarity metric (see section 3 below).

- There is extensive interaction between tone and laryngeal features in Kera, as in many other Chadic languages (Ebert 1979a,b; Wolff 1987; Pearce 1998/99), specifically between L and [voi].

(15) Kera verbs: tone predictable based on consonants (Pearce 1998/99)

- a. C1 = [voi] obstruent; tonal melody = LL or LH  
 /gun-m/ gùn-ùm ‘awaken you (masc.)’  
 /zald-m/ zàld-àm ‘hit you (masc.)’  
 /gun-ú/ gùn-ù ‘awaken him’  
 /zald-ú/ zàld-ú ‘hit him’
- b. C1 = other; tonal melody = MM or HH  
 /mirk-m/ mīrk-īm ‘greet you (masc.)’  
 /mirk-ú/ mīrk-ú ‘greet him’

- L induced by [voi] is involved the following processes:
  - L blocks leftward spread of H from high-toned suffix;
  - L spreads to toneless affix vowel (often epenthetic, but not always);
  - L spreads to high-toned suffix (under certain conditions), delinking the H.

(16) Tone patterns associated with affixal voicing alternations (nominal /k-/):

- /k-tā:tá-w/ → k̄-tā:tá-w ‘cooking pots’  
 /k-dàjgá-w/ → ḡ-dàjgá-w ‘jugs’  
 /k-dzà:ŋà-w/ → ḡ-dzà:ŋá-w ‘footstools’

- Phonation-determined tone on  $\sigma_1$  of root spreads to (epenthetic) affix vowel; [voi] assimilation is therefore taking place across an L-toned vowel.
- Apparent distributional generalization: obstruents which agree in [voi] are *always* separated by a L-toned vowel!
- Suggestive evidence that an intervening L is a necessary condition for [voi] agreement:

(17) Intervening H appears to block [voi] agreement between root and prefix:

- /k-ágàj/ → kógàj ‘hoes’ (Pearce 1998/99: 51)  
 (not \*\*gógàj)

### 2.1.3. Voicing agreement and tone in Ngizim

- Voicing agreement, by regressive assimilation in [voi] between pulmonic obstruents, is also attested in Ngizim (West Chadic, Nigeria; Schuh 1978, 1997).
- Historically, \*/T...D/ > /D...D/; fricatives as well as plosives are triggers and undergoers of agreement.
- Agreement is strictly morpheme-internal, no alternations result. Several exceptions exist due to borrowing. As in Kera, *implosives* fail to trigger [voi] agreement:

## (18) Voicing agreement in Ngizim (Schuh 1997)

- |    |        |              |                        |                             |
|----|--------|--------------|------------------------|-----------------------------|
| a. | gâ:zá  | ‘chicken’    | < *k...z               | (cf. Hausa /kàazáa/)        |
|    | dá:bâ  | ‘woven tray’ | < *t...b               | (cf. Hausa /tàafii/ ‘palm’) |
|    | zèdù   | ‘six’        | < *s...d               | (cf. Hausa /ʃídà/)          |
| b. | kì:dú  | ‘eat (meat)’ | (not > **gìdú)         |                             |
|    | fádú   | ‘four’       | (not > **vádú)         | [Schuh (1978:260)]          |
|    | pédǎk  | ‘morning’    | (not > **bédǎk)        |                             |
| c. | tâ:bâ  | ‘tobacco’    | (from Hausa /tá:bà:/)  |                             |
|    | kàrgûn | ‘medicine’   | (from Kanuri /kùrgûn/) |                             |

- Little evidence to suggest that [voi] agreement in Ngizim is a synchronically active restriction, though it clearly was at some earlier stage.
- No obvious (synchronic) connection between tone patterns and the [voi] assimilation.
- Clear evidence of interdependence of [voi] and L tone in Ngizim, both in the diachronic development of tone and in synchronic tonal processes (Schuh 1971; Wolff 1987; Bradshaw 1999):
  - In L-H-H sequences, an intervening [voi] pulmonic obstruent triggers rightward L-spread (resulting in L-L-H);
  - In H-L-H sequences, an intervening [voi] pulmonic obstruent blocks rightward H-spread (which would otherwise result in H-H-H).
- Given the pervasive interaction between L and [voi] in Ngizim phonology (synchronic and diachronic)—and given that implosives pattern alike in tonal processes and in [voi] agreement—it is at least a *plausible conjecture* that tone was implicated in the development of Ngizim [voi] agreement.

**2.2. Analogical extension of other laryngeal harmony?**

- In a small number of cases, obstruent [voi] agreement coexists with agreement in either [spr.gl.] or [constr.gl.]; the result is a three-way agreement system.
- Evidence suggests that in these systems, agreement in [voi] has a secondary status and is likely the result of analogical extension/expansion of a previous two-way system to a three-way system.
- A shared property is the limitation of the laryngeal harmony (including [voi] agreement) to *plosives*, excluding fricatives.

*2.2.1. Voicing and aspiration agreement in Zulu/Ndebele*

- A general morpheme-internal laryngeal harmony among (non-click) stops occurs in Zulu and Ndebele (Bantu, South Africa/Zimbabwe; Khumalo 1987; Hyman 1999; Hansson 2001a).
- Other things being equal, roots contain only T...T, T<sup>h</sup>...T<sup>h</sup> or D...D, never disharmonic combinations like \*T...T<sup>h</sup> or \*T<sup>h</sup>...D

(19) Harmonic roots in Zulu (Khumalo 1987):

- a. -k<sup>h</sup>et<sup>h</sup>a ‘to choose’  
-p<sup>h</sup>at<sup>h</sup>a ‘to hold’
- b. -guba ‘to dig’
- c. -peta ‘to dig up’  
-tapa ‘to collect [honey, etc.]’

(20) Agreement plays active role in Zulu loanword adaptation (Khumalo 1987):

- a. í-k<sup>h</sup>ô<sup>t</sup>h<sup>o</sup> ‘court’ (from English *court*, /k<sup>h</sup>ɔt/)
- b. úm-bídi ‘conductor’ (from English *beat*, /bit/)

- Ndebele has same laryngeal harmony as Zulu. In both languages, aspiration harmony is overridden by a general restriction which limits [k<sup>h</sup>] to root-initial position (Khumalo 1987; Hyman 1999; see Hansson 2001a for discussion):<sup>2</sup>

(21) Ndebele: Aspiration harmony blocked by ban on medial [k<sup>h</sup>] (data from CBOLD):

- p<sup>h</sup>eka ‘cook, brew’ (not \*-p<sup>h</sup>ek<sup>h</sup>a)
- p<sup>h</sup>ika ‘argue, deny’ (not \*-p<sup>h</sup>ik<sup>h</sup>a)
- t<sup>h</sup>uka ‘cook, brew’ (not \*-t<sup>h</sup>uk<sup>h</sup>a)
- t<sup>h</sup>ikaza ‘be disturbed’ (not \*-t<sup>h</sup>ik<sup>h</sup>aza)

- Aspiration harmony between *homorganic* stops in turn overrides the prohibition against non-initial [k<sup>h</sup>] (Hyman 1999; Hansson 2001a).

(22) Ndebele: Aspiration harmony on *homorganic* Cs trumps ban on medial [k<sup>h</sup>]:

- k<sup>h</sup>ok<sup>h</sup>a ‘pull, draw out’
- k<sup>h</sup>uk<sup>h</sup>ula ‘sweep away’

- Voicing harmony behaves in the very same way with respect to word-medial velars:
  - If trigger is a *heterorganic* stop (labial, coronal), then harmony is thwarted, resulting in medial [k] (23a);
  - If trigger is a *homorganic* stop (velar), then harmony is enforced resulting in medial [g] (23b).

(23) Ndebele: Voicing harmony and medial [g] vs. [k] (data from CBOLD):

- a. -dakwa ‘be drunk’ (not \*-dagwa)  
-dikisa ‘palpitate, twitch’ (not \*-digisa)
- b. -guga ‘wear out’

- Problem: There is no prohibition against non-initial [g] to account for (23a)!

---

<sup>2</sup> Strictly speaking, /k<sup>h</sup>/ does not need to be in absolute root-initial position, as long as it is *the first consonant* in the root (e.g., Ndebele /-ak<sup>h</sup>a/ ‘build’, /-ok<sup>h</sup>a/ ‘roast’).

(24) Ndebele: Non-root-initial [g] occurs freely in non-harmony contexts:

-fuga	‘push a cart’
-lagisa	‘send cattle to grazing place’
-huga	‘allure, entice’

- Patterning of voicing agreement with respect to targetting of velars (and role of trigger-target homorganicity) seems to be *modelled after* the patterning of aspiration agreement. The latter is motivated by independent phonotactic factors.
- This suggests that [voi] agreement is of *secondary* origin in Zulu/Ndebele, most likely due to the (analogical) generalization of aspiration harmony to an all-encompassing laryngeal harmony, subsuming [voi] as well.
- Further issue: Much is unclear about the diachronic origin of the [voi] stop series as such in Zulu/Ndebele; it appears to be the result of various secondary developments.

### 2.2.2. Voicing and ejection agreement in Chaha

- Root-internal laryngeal harmony among stops occurs in Chaha, a Gurage dialect (Semitic, Ethiopia; Leslau 1971; Banksira 2000; Rose & Walker 2000, to appear). The features involved are [voi] and [constr.gl.], separating plain voiceless, voiced, and ejective stops.
- Agreement is most consistently enforced between stops which are adjacent within the consonantal root (e.g. /tʰikʰir/ ‘hide!’) but is also highly significant between non-root-adjacent consonants (e.g. /tʰiβəkʰ/ ‘be tight!’; Rose & Walker to appear).
- Note: Due to the usual Semitic OCP-Place restrictions on root consonants, nearly all relevant stop combinations are *heterorganic*.

(25) Harmonic roots in Chaha (cited from Rose & Walker to appear)

a.	kʰitʰir	‘kill!’
	nitʰikʰ	‘snatch!’
b.	gidir	‘put to sleep!’
	əd(i)g	‘make fall!’
c.	kitf	‘hash [meat]!’
	tiks	‘set on fire!’

- Comparison with related languages shows evidence of regressive assimilation between ejectives and voiced stops:

(26) Comparative evidence for regressive laryngeal harmony (Rose & Walker 2000)

a.	<i>Chaha</i>	<i>Amharic</i>	
	tʰikʰəkʰ	dikʰəkʰ	‘be crushed/grounded!’
	witʰəkʰ	widəkʰ	‘snatch!’
b.	gida	kʰida	‘draw liquid!’
	midad	mitʰad	‘griddle!’

- Interaction between [voi] and [constr.gl.] stops might be seen as a restriction against the cooccurrence of stops with *conflicting* (privative) laryngeal features; such effects are attested elsewhere (MacEachern 1999; Hansson 2001a):
  - ‘Peruvian’ Aymara: [constr.gl.] stops and [spr.gl.] stops cannot cooccur (\*K’...T<sup>h</sup>, \*T’...K<sup>h</sup>, \*K<sup>h</sup>...T’, etc.), though each may freely cooccur with plain voiceless stops which lack laryngeal specifications (i.e. K’...T, T<sup>h</sup>...K, etc.).
  - Old Georgian: [constr.gl.] stops and (phonetically) [spr.gl.] stops cannot cooccur, though each may freely cooccur with stops from the plain voiced series.
- Comparison with related languages has yet to reveal any active implementation of agreement through assimilation in voiced/plain combinations (D...K, K...D, etc.) or ejective/plain combinations (T’...K, K...T’, etc.). Nevertheless, such combinations are virtually nonexistent in the Chaha lexicon.
- In the case of such “pure” agreement in either [constr.gl.] or [voi] alone, Rose & Walker (to appear) find in their database of 855 verb roots:
  - a single exception to pure [constr.gl.] agreement (K’...T, T’...K, etc.);
  - numerous exceptions to pure [voi] agreement (G...T, D...K, etc.), which thus seems to be less strictly enforced.

### 3. Inertness of implosives and the similarity metric

- Recall that in the Chadic languages examined in §2.1, implosive are consistently *inert*, failing to trigger [voi] agreement, unlike pulmonic voiced obstruents (stops and fricatives).

(27) Implosives as non-triggers of [voi] assimilation in Kera (a) and Ngizim (b):

a.	bókáj	[no gloss]
	đúpí	‘to scoop (pl.)’
	kédé	‘to add on’
	tʃérdé	‘to press’
b.	kì:đú	‘eat (meat)’
	fǒđú	‘four’
	pédǎk	‘morning’

- The analysis of [voi] assimilation as *similarity*-driven agreement (Rose & Walker 2000, to appear; Walker 2000, 2001; Hansson 2001a) must interpret the lack of agreement in (27) as a similarity effect: the similarity between implosives and (voiceless) pulmonic obstruents is *below* the threshold at which agreement is required.
- Segment-to-segment similarity is best calculated in terms of the distinct natural classes arising from the segment inventory in question, and the degree of overlap in the natural classes the two segments belong to (Frisch 1996; Frisch et al. 2004; see Pierrehumbert 1993 for a predecessor of the natural-class similarity metric):

(28) Similarity metric based on distinct natural classes (Frisch et al. 2004)

$$\text{Similarity} = \frac{\text{Shared natural classes}}{\text{Shared natural classes} + \text{Non - shared natural classes}}$$

- The metric in (28), as well as any metric based on simple feature-counting, makes the wrong prediction for the behaviour of implosives in Kera and Ngizim (Hansson 2001a).
- In both languages, [voi] agreement involves all pairs of pulmonic obstruents, regardless of differences in place of articulation and/or manner (once we have factored out the secondary sporadic devoicing of many Kera fricatives). A pulmonic-implosive pair is *not* subject to [voi] agreement, even if the segments are identical in all other features.
- Consequently, if [voi] agreement is triggered by a high degree of similarity, we must assume that pairs like /t...v/ or /f...d/ are being counted as “more similar” than /t...d/ or /b...p/. This is incompatible with any reasonable similarity metric.

(29) Similarity values for /t...v/ vs. /t...d/ given Ngizim segment inventory:

- a. /t...v/:  $7/(7+57) = 0.11$  (harmony triggered; ∴ above threshold)  
 b. /t...d/:  $21/(21+24) = 0.47$  (harmony *not* triggered; ∴ below threshold?!)

- From a synchronic and diachronic perspective, attempting to explain the inert behaviour of implosives in terms of relative similarity is highly problematic.
- If [voi] agreement in Kera and Ngizim is instead due to reanalysis of tone-voicing interaction effects, the inertness of implosives is *entirely as expected!*

(30) Kera verb tones: Implosives do not pattern with [voi] obstruents (Ebert 1979a):

- |    |          |        |                  |                        |
|----|----------|--------|------------------|------------------------|
| a. | /bəŋ-é/  | bìŋ-ì  | ‘to open’        |                        |
|    | /gun-é/  | gùn-ì  | ‘to wake [s.o.]’ |                        |
|    | /zèl-é/  | zèl-è  | ‘to boil’        |                        |
|    | /var-é/  | vèr-è  | ‘to choose’      |                        |
| b. | /kal-é/  | kél-é  | ‘to enter’       |                        |
|    | /ta:k-é/ | tá:k-é | ‘to let’         |                        |
|    | /pat-é/  | pét-é  | ‘to displume’    |                        |
|    | /fel-é/  | fél-é  | ‘to find’        |                        |
| c. | /dǎŋ-é/  | dǐŋ-í  | ‘to think’       |                        |
|    | /bal-é/  | bél-é  | ‘to nail’        |                        |
|    | /dók-é/  | dók-é  | ‘to manage’      | [Pearce (1998/99: 68)] |
| d. | /mal-é/  | mél-é  | ‘to lay’         |                        |
|    | /nu:m-é/ | nú:m-ì | ‘to groan’       |                        |

(31) Kera noun tones: Implosives pattern with voiceless obstruents (Pearce 1998/99):

- a. C1 = “neutral”; tone pattern L-L, L-H, H-L or H-H
- |       |                 |
|-------|-----------------|
| là:gà | ‘type of knife’ |
| mò:mó | ‘grandfather’   |
| mésèw | ‘adultery’      |
| wá:lé | ‘joy’           |
- b. C1 = [voi] pulmonic obstruent; tone pattern L-L or L-H
- |       |               |
|-------|---------------|
| bègàr | ‘antelope’    |
| bò:bè | ‘cold season’ |
| dà:rè | ‘friend’      |
| gùdùl | ‘song’        |
| gèṅé  | ‘men in bush’ |
| bò:mé | ‘game’        |
| zèbùl | ‘soap’        |
- c. C1 = voiceless (pulmonic) obstruent; tone pattern M-M, M-H, H-M or H-H
- |       |             |
|-------|-------------|
| kēlēw | ‘horn’      |
| tērnō | ‘daughter’  |
| tā:tá | ‘large jug’ |
| kūntí | ‘flour’     |
| tápāj | ‘thunder’   |
| kúrkí | ‘bull’      |
| pájáj | ‘mountain’  |
- d. C1 = implosive; tone pattern M-M, M-H, H-M or H-H (same as (c))
- |       |                  |
|-------|------------------|
| ḃō:rō | ‘bow and arrows’ |
| ḃērāw | ‘type of bird’   |
| ḃárká | ‘ant hill’       |

- In the literature on tonogenesis and tone-consonant interaction, it is well known that implosives have a tendency to *raise* tone—or at any rate lack the tendency of voiced pulmonics to *lower* tone (Greenberg 1970; Hombert 1978; Hombert et al. 1979; Bradshaw 1999).
- If implosives are not correlated with L tone, and [voi] agreement result from a reinterpretation of L-induced voicing effects, then we expect implosives *not* to trigger [voi] agreement.
- Relative similarity of implosives vis-à-vis other obstruents to potential target segments is simply irrelevant.

#### 4. The residue: “natural” voicing agreement?

- A very small residue of [voi] agreement cases remain which cannot be “explained away” as due to reanalyzed tone-voicing interaction or analogical extension of agreement in other laryngeal features.
- These show important characteristics, also typical of many other “rare” types of consonant harmony:

- extremely sensitive to similarity, applying only to consonants which are identical in all other features (place, manner, etc.)—implementation of [voi] agreement results in complete segmental identity;
- strictly root-internal cooccurrence restrictions;
- Clearest example is Ngbaka (Adamawa-Ubangi, Dem. Rep. of Congo; Thomas 1963; Mester 1988; Sagey 1990; Walker 2000, 2001; Hansson 2001a; Rose & Walker to appear), where [voi] agreement is parasitic on identity in place of articulation.

(32) Voicing agreement among homorganic oral stops in Ngbaka (Thomas 1963):

- |    |      |               |
|----|------|---------------|
| a. | tita | ‘grandparent’ |
|    | pɛpu | ‘vent’        |
| b. | babã | ‘companion’   |
| c. | duka | ‘shoulder’    |
|    | kɛbɛ | ‘fast’        |
|    | gapa | ‘to divide’   |

- Voicing agreement forms part of a bigger system; not only are homorganic T...D/D...T sequences prohibited, but so are homorganic <sup>N</sup>D...D/D...<sup>N</sup>D and N...<sup>N</sup>D/<sup>N</sup>D...N sequences.

(33) “Prenasalization agreement” among homorganic voiced stops in Ngbaka:

- |    |          |             |
|----|----------|-------------|
| a. | babã     | ‘companion’ |
| b. | mbɛ̃:mbɛ | ‘snail’     |
| c. | báŋgá    | ‘jaw’       |

(34) “Nasal agreement” between homorganic nasals and prenasals in Ngbaka:

- |    |             |                       |
|----|-------------|-----------------------|
| a. | nané        | ‘today’               |
| b. | mbɛ̃:mbɛ    | ‘snail’               |
|    | ŋmgbãŋmgbɔ̀ | ‘caterpillar species’ |
| c. | màŋgà       | ‘net’                 |
| d. | boma        | ‘how’                 |

- On a similarity scale T – D – <sup>N</sup>D – D, homorganic combinations drawn from *adjacent categories* on the scale do not mix. If a pair of consonants differs in place and/or nasality, [voi] agreement is not enforced; similarly, if a pair of consonants differs in place and/or voicing, [nas] agreement is not enforced.
- A second potential example of [voi] agreement that remains is Hausa (West Chadic, Nigeria; Parsons 1970; MacEachern 1999; Newman 2000; Hansson 2001a). Ejectives and implosives may not cooccur within Hausa roots, which might be construed as [voi] agreement among segments which share [constr.gl.]. This forms part of a larger generalization on laryngeal cooccurrence: in Hausa, two cooccurring [constr.gl.] segments must in fact be *identical in all features* (including [voi], as well as place).

## 5. Conclusions

- “Voicing agreement” appears to be a heterogeneous category of phenomena from a diachronic-evolutionary perspective.
- At least some cases have “unnatural” histories involving analogical restructuring and/or analogical extension.
- Voicing agreement in Chadic (Kera, Ngizim) is likely an indirect result of extensive interaction and interdependence between tone and the laryngeal features of obstruents, in particular between Low and [voi]. This explains the otherwise-anomalous behaviour of implosives in Chadic voicing agreement systems.
- Voicing agreement in Southern Bantu (Zulu, Ndebele) is likely secondary, due to a generalization of agreement from [spr.gl.] to all laryngeal features. This would help explain why [voi] agreement fails to give rise to root-internal [g] even though that segment is allowed in that position. A similar analogical extension may have played a part in the development of laryngeal agreement in Ethio-Semitic (Chaha).
- The small residue of cases shows characteristics that are highly reminiscent of morpheme-internal cooccurrence restrictions such as OCP-Place (see Frisch et al. 2004 and references cited there).

## References

- Banksira, Degif Petros. 2000. *Sound mutations: The morphophonology of Chaha*. Amsterdam: John Benjamins.
- Blevins, Juliette. To appear a. Antigemination: Natural or unnatural history? *Proceedings of BLS 29*, ed. by P. Nowak and C. Yoquelet. Berkeley: Berkeley Linguistic Society.
- Blevins, Juliette. To appear b. Consonant epenthesis: Natural and unnatural histories. *Proceedings of the Workshop on Explaining Linguistic Universals*, ed. by Jeff Good. Oxford: Oxford University Press.
- Blevins, Juliette. To appear c. *Evolutionary phonology*. Cambridge: Cambridge University Press.
- Blevins, Juliette and Andrew Garrett. 1998. The origins of consonant-vowel metathesis. *Language* 74: 508-56.
- Blevins, Juliette and Andrew Garrett. To appear. The evolution of metathesis. In *Phonetically driven phonology*, ed. by Bruce Hayes, Robert Kirchner, and Donca Steriade. Cambridge: Cambridge University Press.
- Bradshaw, Joel. 1979. Obstruent harmony and tonogenesis in Jabêm. *Lingua* 49: 189-205.
- Bradshaw, Mary. 1999. *A crosslinguistic study of consonant-tone interaction*. Doctoral dissertation, Ohio State University.
- Dempwolff, Otto. 1939. *Grammatik der Jabêm-Sprache auf Neuguinea*. (Abhandlungen aus dem Gebiet der Auslandskunde, 50.) Hamburg: Friedrichsen, de Gruyter & Co.
- Ebert, Karen. 1979a. *Sprache und Tradition der Kera (Tschad), Teil III: Grammatik*. (Marburger Studien zur Afrika- und Asienkunde, Serie A: Afrika, 15.) Berlin: Reimer.
- Ebert, Karen. 1979b. Consonant-tone harmony in Kera. *Multilinguisme dans les domaines bantou du nord-ouest et tchadique, le point de la question en 1977*, ed. by Luc Bouquiaux. (LACITO documents Afrique, 3.) Paris: SELAF.
- Frisch, Stefan A. 1996. *Similarity and frequency in phonology*. Doctoral dissertation, Northwestern University.

- Frisch, Stefan A., Janet B. Pierrehumbert and Michael B. Broe. 2004. Similarity avoidance and the OCP. *Natural Language and Linguistic Theory* 22: 179-228.
- Garrett, Andrew and Juliette Blevins. To appear. Morphophonological analogy. In *The nature of the word: Essays in Honor of Paul Kiparsky*, ed. by Sharon Inkelas and Kristin Hanson. Cambridge, MA: MIT Press.
- Greenberg, Joseph H. 1970. Some generalizations concerning glottalic consonants, especially implosives. *International Journal of American Linguistics* 36: 123-145.
- Hansson, Gunnar Ólafur. 2001a. *Theoretical and typological issues in consonant harmony*. Doctoral dissertation, University of California, Berkeley.
- Hansson, Gunnar Ólafur. 2001b. The phonologization of production constraints: Evidence from consonant harmony. *Proceedings of CLS 37*, ed. by Mary Andronis, Christopher Ball, Heidi Elston and Sylvain Neuvel, pp. 187-200. Chicago: Chicago Linguistic Society.
- Hombert, Jean-Marie. 1978. Consonant types, vowel quality, and tone. *Tone: A linguistic survey*, ed. by Victoria A. Fromkin, pp. 77-112. New York: Academic Press.
- Hombert, Jean-Marie, John J. Ohala & William Ewan. 1979. Phonetic explanations for the development of tone. *Language* 55: 37-58.
- Hyman, Larry M. 1999. Aspiration and voicing harmony in Nguni? Seminar presentation, University of California, Berkeley, September 1999.
- Hyman, Larry M. and Russell G. Schuh. 1974. Universals of tone rules: evidence from West Africa. *Linguistic Inquiry* 5: 81-115.
- Khumalo, James S. M. 1987. *An autosegmental account of Zulu phonology*. Doctoral dissertation, University of Witwatersrand.
- Leslau, Wolf. 1971. *Etymological dictionary of Gurage (Ethiopic)*. Wiesbaden: Harrassowitz.
- MacEachern, Margaret. 1999. *Laryngeal co-occurrence restrictions*. New York: Garland.
- Maddieson, Ian. 1974. A note on tone and consonants. *UCLA Working Papers in Phonetics* 27: 18-27.
- Maddieson, Ian. 1976. A further note on tone and consonants. *UCLA Working Papers in Phonetics* 33: 131-159.
- Mester, R. Armin. 1988. *Studies in tier structure*. New York: Garland.
- Newman, Paul. 2000. *The Hausa language: An encyclopedic reference grammar*. New Haven: Yale University Press.
- Odden, David. 1994. Adjacency parameters in phonology. *Language* 70: 289-330.
- Ohala, John J. 1992. What's cognitive, what's not, in sound change. *Diachrony within synchrony: Language history and cognition*, ed. by G. Kellermann & M. Morrissey, pp. 309-355. Frankfurt: Peter Lang.
- Ohala, John J. 1993. The phonetics of sound change. *Historical linguistics: Problems and perspectives*, ed. by Charles Jones, pp. 237-278. London: Longman.
- Ohala, John J. 1994. Towards a universal, phonetically-based, theory of vowel harmony. *Proceedings of ICSLP '94*, pp. 491-494.
- Parsons, F. W. 1970. Is Hausa really a Chadic language? Some problems of comparative phonology. *African Language Studies* 11: 272-88.
- Pearce, Mary. 1998/99. Consonants and tone in Kera (Chadic). *Journal of West African Languages* 27: 33-70.
- Peng, Long. 1992. *A unified theory of tone-voice*. Doctoral dissertation, University of Arizona.
- Pierrehumbert, Janet B. 1993. Dissimilarity in the Arabic verbal roots. *Proceedings of NELS* 23: 367-381.
- Poser, William J. 1981. On the directionality of the tone-voice correlation. *Linguistic Inquiry* 12: 483-488.

- Prince, Alan and Paul Smolensky. 1993. *Optimality theory: Constraint interaction in generative grammar*. Report no. RuCCS-TR-2. New Brunswick, NJ: Rutgers University Center for Cognitive Science.
- Rose, Sharon and Rachel Walker. 2000. Long-distance consonant agreement. Paper presented at *NELS 31*, Georgetown University, October 7, 2000.
- Rose, Sharon and Rachel Walker. To appear. A typology of consonant agreement as correspondence. *Language*.
- Ross, Malcolm D. 1993. Tonogenesis in the North Huon Gulf chain. *Tonality in Austronesian languages*, ed. by Jerold A. Edmondson and Kenneth J. Gregerson, pp. 133-155. (Oceanic Linguistics Special Publications, 24.) Honolulu: University of Hawaii Press.
- Ross, Malcolm D. 1995. Yabem. *Comparative Austronesian dictionary: An introduction to Austronesian studies*, ed. by Darrell T. Tryon, pp. 699-718. Berlin: Mouton de Gruyter.
- Sagey, Elizabeth. 1990. *The representation of features and relations in non-linear phonology*. New York: Garland.]
- Schuh, Russell G. 1971. Verb forms and verb aspects in Ngizim. *Journal of African Languages* 10: 47-60.
- Schuh, Russell G. 1978. Bade/Ngizim vowels and syllable structure. *Studies in African Linguistics* 9: 247-283.
- Schuh, Russell G. 1997. Changes in obstruent voicing in Bade/Ngizim. Ms. University of California, Los Angeles.
- Thomas, Jacqueline M. C. 1963. *Le parler ngbaka de Bokanga: Phonologie, morphologie, syntaxe*. Paris: Mouton.
- Walker, Rachel. 2000. Long-distance consonantal identity effects. *Proceedings of WCCFL 19*, ed. by Roger Billerey and Brook Lillehaugen, pp. 532-545. Somerville, MA: Cascadilla Press.
- Walker, Rachel. 2001. Consonantal correspondence. *Proceedings of the Workshop on the Lexicon in Phonetics and Phonology*, ed. by Robert Kirchner, Joe Pater and Wolf Wikeley, pp. 73-84. (Papers in Experimental and Theoretical Linguistics, 6.) Edmonton: Dept. of Linguistics, University of Alberta.
- Wolff, Ekkehard. 1987. Consonant-tone interference in Chadic and its implications for a theory of tonogenesis in Afroasiatic. *Colloques et séminaires: Langues et cultures dans le bassin du lac Tchad: Journées d'études les 4 et 5 septembre 1984*, ed. by Daniel Barreteau. Paris: ORSTROM.