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Retroflex (consonant) harmony in Kalasha*

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1. Introduction

- In this paper we investigate co-occurrence restrictions on coronal consonants in Kalasha (Dardic, Indo-Aryan), evaluating two current theories of consonant harmony: local feature spreading (Shaw 1991; Gafos 1999) and long-distance agreement by correspondence (ABC) (Hansson 2001; Rose & Walker 2004).
- Our study reveals that Kalasha roots exhibit a pattern of retroflex consonant harmony (and coronal place harmony, more broadly) that is sensitive to the relative similarity of coronal obstruents in terms of their manner of articulation.
- We argue that the data are consistent with the typology and predictions of the ABC model, which encodes featural similarity, but are not predicted by the feature spreading models as they stand.

2. Background: Retroflex consonant harmony

- Retroflex consonant harmony is an assimilatory effect or co-occurrence restriction holding between consonants that are separated by a vowel, and possibly other segments, resulting in identical retroflex or non-retroflex features/gestures on those consonants.
- Previously identified cases of retroflex harmony among obstruents involve either coronal stops or coronal sibilants (affricates and/or fricatives) (1).

(1) Cases of retroflex consonant harmony reported in Hansson (2001) and Rose & Walker (2004)

	Language (genus, family)	*Retroflex vs. non-retroflex harmony*	
		Stops	*Sibilants (fricatives/affricates)*
a.	Malto (Northern Dravidian, Dravidian)	√	--
	Javanese (Sundic, Austronesian)	√	--
	Pohnpeian (Oceanic, Austronesian)	√	--
	Gaagudju (Gaagudju, Australian)	√	--
	Gooniyandi (Bunuban, Australian)	√	--
	Mayali (Gunwinygic, Australian)	√	--
b.	Benchnon Gimira (Omotic, Afro-Asiatic)	--	√
	Rumsen (Costanoan, Penutian)	--	√
	Nebaj Ixil (Mayan)	--	√
	South Peruvian Quechua (Quechuan)	--	√
	Wanka Quechua (Quechuan)	--	√
	Capanahua (Panoan)	--	√

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- Malto and Gimira are representative of the typology of retroflex harmony:
  - Malto: coronal stops in a root must be either retroflex or dental (2).
  - Gimira: posterior sibilant affricates and/or fricatives within a root must be either retroflex or palato-alveolar (3).

(2) Retroflex harmony in Malto (Mahapatra 1979; Hansson 2001)

a.	ʈuːɖ	‘tiger’
	dudu	‘mother’
	ɖanɖa	‘staff’
	toːtotri	‘quickly’
b.	*ʈ...t, *d...ɖ, etc.	

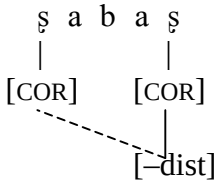
(3) Retroflex harmony in Gimira (tones omitted) (Breeze 1990; Rose & Walker 2004)

a.	ʂaʂ	‘vein’
	ʃatʃ	‘stretcher’
	ʈʂ’uʈʂ’	‘louse’
	ʧ’aʃt	‘be pierced’
b.	*ʂ…ʃ , *ʧ…ʈʂ, *ʂ…ʧ, etc.	

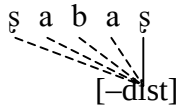
- Current theories of consonant harmony can be classified into two broad groups: those that analyze harmony as feature *spreading* and those that analyze it as feature *agreement*.
- *Local Feature Spreading*: The harmonic feature spreads locally to segments that are adjacent (in some sense) within a given domain. All segments within the domain that are contrastive for the spreading feature are either triggers, targets or blockers of harmony.
  - Locality can be defined in terms of autosegmental tiers (4a). Intervening segments are transparent due to underspecification of the relevant tier (e.g., Shaw 1991).
  - Locality can be defined in strict segmental terms (4b). The spreading feature permeates all intervening segments, which may appear transparent if the feature has no significant audible effect on them (e.g., Gafos 1999).

(4) Harmony as local feature spreading

a. Tier-based locality

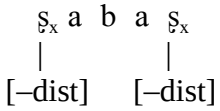


b. Strict segmental locality



- *Agreement by Correspondence* (Rose & Walker 2004; Hansson 2001): A correspondence relation is established between segments in an output string if they are highly similar. Agreement for the harmonic feature is enforced between corresponding segments. Segments that do not enter into the correspondence relation are transparent (5).

(5) Harmony as feature agreement by correspondence (ABC)



- Both models of consonant harmony can account for the patterns of retroflex harmony in languages like Malto and Gimira, where harmony holds between all coronal segment types that exhibit contrastive retroflexion.
- However, in each case the contrast between retroflex and non-retroflex consonants is limited to one manner class: either to stops, as in Malto (6a), or to (a subset of) sibilant affricates and fricatives, as in Gimira (6b).

(6) Coronal obstruents in Malto (a) and Gimira (b) (Mahapatra 1979; Breeze 1990)

a.

ʈ ɖ	ʧ ʤ	
s ð		ʦ ʣ

b.

t t’ d	t^{j} t’^{j} d^{j}			
ts ts’ s z	s^{j} z^{j}	s^{w}	ʦ ʦ’ ʂ ʐ	ʧ ʧ’ ʃ ʒ

- The two theories make different predictions about harmony in languages where retroflexion is contrastive for both stops *and* sibilant affricates and fricatives.
  - The ABC approach relies crucially on featural similarity of participating segments. Thus, it predicts that consonants sharing the same manner of articulation (e.g., two stops, two fricatives, etc.) are more likely to harmonize than consonants with different manners of articulation (e.g., a stop and a fricative, etc.).
  - The spreading approach does not encode similarity, and, consequently, does not predict similarity effects. Rather, all segments contrastive for retroflexion – regardless of manner – are expected to participate in the harmony.
- Until now, these predictions have not been tested. This is largely due to the fact that languages with contrastive retroflexion in stops and affricates/fricatives are typologically rare and relatively under-studied (i.e., only 1% (5/451) of languages in the 1992 version of the *UCLA Segment Inventory Database*).

In this paper we present new data from a language with contrastive retroflexion in stops, affricates and fricatives. The evidence from this language has an important bearing on the theoretical debate concerning the mechanisms of retroflex harmony.

3. Coronal obstruents in Kalasha

- Kalasha is an Indo-Aryan language of the Dardic sub-group spoken in northern Pakistan.
- Contrasts within the coronal obstruent system include (see (7)):
  - 3 manner classes: stops, affricates, and fricatives

- 3 place classes: 'dentals' (dentals/alveolars), 'retroflexes' (apical post-alveolars), and 'palatals' (laminal post-alveolars)

- In addition, the language has a full set of contrastive retroflex vowels, shown in (8).
- Based on Bashir (2003); Heegård & Mørch (2004); Trail & Cooper (1999).

(7) Kalasha consonant phonemes

Labial	Coronal			Dorsal	Laryngeal
	dental	retroflex	palatal		
p pʰ b bʱ	t tʰ d dʱ ts tsʰ dz s z	ʈ ʈʰ ɖ ɖʱ ʈʂ ʈʂʰ ɖʐ ʂ ʐ	tɕ tɕʰ dʑ dʑʱ ɕ ʑ	k kʰ g gʱ	h
m	n r l ɬ	ɳ (ɽ)	(ɲ)	(ŋ)	
w			j		

(8) Kalasha vowel phonemes

Front		Back	
non-retroflex	retroflex	non-retroflex	retroflex
i ĩ e ẽ	iˑ ĩˑ eˑ ẽˑ	u ũ o õ a ã	uˑ ũˑ oˑ õˑ aˑ ãˑ

- Morgenstierne (1973: 201) observed a few cases of "assimilation at a distance" applying diachronically in Kalasha, most of them involving retroflexion (e.g., ʂiʂ 'head' < *ɕiːʂ).
- To the best of our knowledge Morgenstierne's (1973) passing observation is the only reference to Kalasha consonant harmony in the published literature. The present study is the first attempt to investigate the full extent of consonant harmony in the language.

4. A study of retroflex (coronal) harmony in Kalasha

4.1 Method

- To determine whether Kalasha shows synchronic co-occurrence restrictions on coronal obstruents we compiled a corpus of roots with relevant consonants, based on an updated copy of the database used by Trail & Cooper for their (1999) dictionary of Kalasha.
- An initial search of the data revealed 591 instances of word-initial C_1VC_2 sequences, where both C_1 and C_2 are coronal obstruents. For the purpose of statistical analysis, this list was reduced to a more restrictive set of 218 items by excluding the following items:
  - Duplicate lexemes (i.e., occurring in more than one record).
  - Derived forms (i.e., duplicates of a single root).
  - Morphologically complex words in which C_1 and C_2 belong to separate morphemes.
  - Loanwords from non-Indo-Aryan sources (e.g., Arabic, Persian and English).

- None of the excluded items were exceptional with respect to the pattern of retroflex (and coronal) harmony that emerged from the study.

Counts and statistical analysis

- All 218 items from the set were classified as belonging to one of 36 logically possible combinations of 8 C_1/C_2 place and manner classes (i.e., dental fricatives, palatal fricatives, retroflex fricatives, dental affricates, etc.), collapsing over laryngeal features and C_1/C_2 order (e.g., ɕat 'oath, claim', ʑadri 'co-wife' and daɕ 'ten' were all classified as representing the combination of palatal fricatives with dental stops).
- 'Observed values' (O): counts of roots for each consonant pair.
- 'Expected values' (E): values that would be statistically expected under random occurrence of the phonemes.
- Observed-to-expected ratios (O/E ratios): were computed for each consonant combination to determine whether some combinations are under- or over-represented in the corpus (cf. Frisch et al. 2004).
  - Ratio of 1.00: no difference between observed and expected frequency.
  - Ratio of less than 1.00: the combination is under-represented.
  - Ratio of 0.00: categorical under-representation (complete absence).
  - Ratio of more that 1.00: the combination is over-represented.
  - All under- and over-representations were examined statistically using a chi-square analysis (assuming the significance level of $p < 0.05$, $\chi^2 > 3.84$).

4.2 Results

Table 1. Observed counts of coronals in #CVC sequences (n=218)

C1/C2	s z	ɕ ʑ	ʂ ʐ	ts tsʰ dz	tɕ tɕʰ dʑ dʑʱ	ʈʂ ʈʂʰ ɖʐ	t tʰ d dʱ	ʈ ʈʰ ɖ ɖʱ
s z	6	2	0	1	20	0	22	11
ɕ ʑ		7	0	0	4	0	15	5
ʂ ʐ			9	0	10	3	8	3
ts tsʰ dz				1	1	0	4	1
tɕ tɕʰ dʑ dʑʱ					9	0	17	15
ʈʂ ʈʂʰ ɖʐ						13	7	0
t tʰ d dʱ							9	0
ʈ ʈʰ ɖ ɖʱ								15

Table 2. Expected values, based on a random distribution of consonants

C1/C2	s z	ɕ ʑ	ʂ ʐ	ts tsʰ dz	tɕ tɕʰ dʑ dʑʱ	ʈʂ ʈʂʰ ɖʐ	t tʰ d dʱ	ʈ ʈʰ ɖ ɖʱ
s z	5.30	6.24	6.59	1.39	13.19	5.61	14.24	10.15
ɕ ʑ		1.83	3.85	0.83	7.80	3.30	8.35	5.96
ʂ ʐ			1.95	0.92	8.46	3.50	8.56	6.21
ts tsʰ dz				0.08	1.65	0.73	1.95	1.36
tɕ tɕʰ dʑ dʑʱ					8.03	6.95	18.12	12.78
ʈʂ ʈʂʰ ɖʐ						1.48	7.56	5.38
t tʰ d dʱ							9.36	13.49
ʈ ʈʰ ɖ ɖʱ								4.83

Table 3. Ratios of Observed/Expected values (bold = significant under-/over-representation)

C1/C2	s z	ɕ ʑ	ʂ ʐ	ts tsʰ dz	tɕ tɕʰ dʑ dʑʱ	ʈʂ ʈʂʰ ɖʐ	t tʰ d dʱ	ʈ ʈʰ ɖ ɖʱ
s z	1.13	0.32	**0.00**	0.55	**1.66**	**0.00**	**1.56**	1.16
ɕ ʑ		**3.82**	**0.00**	0.00	0.48	0.00	**1.81**	0.83
ʂ ʐ			**4.62**	0.00	0.97	0.84	0.92	0.57
ts tsʰ dz				**12.11**	0.73	0.00	**1.98**	0.53
tɕ tɕʰ dʑ dʑʱ					1.12	**0.00**	0.90	1.11
ʈʂ ʈʂʰ ɖʐ						**8.77**	0.93	**0.00**
t tʰ d dʱ							0.96	**0.00**
ʈ ʈʰ ɖ ɖʱ								**3.10**

Key observations

- First, most combinations of two stops, two fricatives, and two affricates that *agree* in retroflexion/non-retroflexion are statistically over-represented.
  - This includes combinations of two retroflexes – fricatives (O/E = 4.62), affricates (O/E = 8.77), and stops (O/E = 3.10), or two non-retroflexes – palatal fricatives (O/E = 3.82) and dental affricates (O/E =12.11).
- Second, combinations of two stops, two fricatives, and two affricates that that *disagree* in retroflexion are categorically absent.
  - There are no instances of retroflex fricatives co-occurring with dental or palatal fricatives (O/E = 0.00), retroflex affricates co-occurring with dental or palatal affricates (O/E = 0.00), or retroflex stops co-occurring with dental stops (O/E = 0.00).
- Third, different-manner combinations (i.e., stops with fricatives or affricates, or fricatives wtih affricates) do not show such categorical restrictions and, overall, are not significantly under-represented or over-represented.

An additional observation

- Combinations of two non-retroflex fricatives or two non-retroflex affricates that agree in anteriority/posteriority are also over-represented (significantly, in some cases), while combinations that *disagree* in anteriority/posteriority are under-represented.
  - There are only 3 exceptions in the database with same-manner palatals and dentals: tɕitse maik ‘to talk about this and that’, suɕ, suʑ ‘needle’, ʑazir ~ zazir ‘broken down’.
  - Exceptions of this kind also occur in morphologically complex forms such as ɕ-ase ‘EMPH-that’ (Bashir 2003: 856).
- Thus, the language comes very close to having coronal place harmony between coronal obstruents with the same manner, and not just retroflex harmony.

(9) Fricative/fricative combinations (harmony)

s…s	sastirik	‘to roof a house’	ʑ…ɕ	ʑoɕi	‘Spring festival’
s…z	sazu djek	‘to have a cold’	ʂ…ʂ	ʂiʂ	‘head, top’
ɕ…ɕ	ɕiɕoa	‘handsome’		ʂuʂik	‘to dry’

*s…ʂ, *ɕ…ʂ, *ʐ…ʑ, etc. (no retroflexes with non-retroflexes)

(10) Affricate/affricate combinations (harmony)

ts…ts	tsẽtsaw	‘squirrel’	ʦ…ʦ	ʦaʦukre hik	‘to hold tight’
tɕ…tɕ	tɕitɕilak	‘immature corn’	ʦ...ʦʰ	ʦuʦʰu	‘dried up’
tɕʰ...tɕ	tɕʰatɕi hik	‘to take care of’	ʦʰ...ʦ	ʦʰiʦik	‘to learn’
dʑ…dʑ	dʑadʑ	‘hair, fur’	ʥ...ʦ	ʥaʦ	‘spirit beings’

*ts …ʦ, *tɕ…ʦ, *ʥ…dʑ, etc. (no retroflexes with non-retroflexes)

(11) Stop/stop combinations (harmony)

t…t	daʷu tatu	‘festival of beans’	ʈ…ʈ	ʈoʈ	‘apron’
tʰ…d	tʰedi	‘now’	ʈʰ…ʈ	ʈʰeʈ karik	‘to scatter’
d…d	dodak hik	‘to wait’	ɖ…ɖ	ɖuɖik	‘to sleep’

*t …ʈ, *d…ɖ, *ʈ…d, etc. (no retroflexes with non-retroflexes)

(12) Stop/affricate combinations (no harmony)

ʦ…t	ʦat	‘moment’	ʈ…tɕ	ʈõtɕuk	‘active’
d…ʦ	diʦ	‘period of abstinence’	ts…ʈ	tsaʈẽgik	‘to move’
tɕ…ʈ	tɕuʈik	‘to touch’			

(13) Stop/fricative combinations (no harmony)

t…ʂ	tuʂ	‘straw, chaff’	ɖ^{ɦ}…ɕ	ɖ^{ɦ}uɕak	‘a dance’
ʂ…t	ʂit	‘tight-fitting’	ʈ…s	ʈosu djek	‘to peck’
ɕ…ʈʰ	ɕoʈʰa	‘a growth’	s…ʈ	saʈuk	‘apple sauce’

(14) Affricate/fricative combinations (no harmony)

tɕ…ʂ	tɕaʂ ~ tɕaʂʈ	‘lunch’	ʂ…tɕ	ʂatɕ	‘shelter’

4.3 Discussion

- Coronal consonant harmony is ambiguous with respect to feature agreement or spreading: Features pertaining to the tongue tip can potentially permeate (i.e., spread through) vowels and non-coronal consonants with little or no audible effect, thus giving the impression of transparency and long-distance agreement (Gafos 1999).
- However, at least some forms of consonant harmony *cannot* be the result of spreading. For instance, nasal and laryngeal consonant harmony can hold between consonants over long domains without affecting intervening segments, even when those segments are potential targets for nasality or laryngeal features (Hansson 2001; Rose & Walker 2004).
- Such cases of long distance assimilation are always sensitive to the relative similarity of participating consonants, while local assimilation is not.
- For this reason, Rose & Walker (2004) posit a typological distinction between similarity-sensitive assimilation, which is the product of agreement by correspondence, and similarity-insensitive patterns, which are the product of local feature spreading.
- To the extent that a pattern of coronal harmony exhibits similarity effects comparable to other forms of harmony, which can only be attributed to agreement, Rose & Walker suggest that a unified account is preferable – i.e., similarity-sensitive coronal harmony is also the result of agreement by correspondence.

4.3.1 The similarity effect

- The study reveals that Kalasha exhibits robust patterns of retroflex harmony (and more generally coronal harmony) applying to coronal obstruents within roots, both across intervening vowels and consonants. Similarity plays a critical role in Kalasha harmony: it holds only between coronal obstruents that have the same manner of articulation.
- Thus, the data are more compatible with the typology and predictions of agreement by correspondence than with those of feature spreading.
- The ABC model relies crucially on featural similarity of participating segments. Thus, it predicts that pairs of consonants sharing the same manner of articulation (i.e., the same values for [±continuant, ±strident]) are more likely to harmonize than pairs with different manners of articulation.
- While retroflex harmony could be implemented as feature spreading, there is nothing in the spreading models that would predict harmony between two stops but not between a stop and a fricative, when retroflexion is contrastive for both.

4.3.2 Retroflex vowels

- Unlike most other languages, tongue tip orientation *is* relevant for the vowels of Kalasha, as the language has a full set of retroflex vowels contrastive with their non-retroflex counterparts (Bashir 2003; Heegård & Mørch 2004; see (8)).
- There is evidence that the feature responsible for retroflexion on vowels is the same feature responsible for retroflexion on consonants. Retroflex vowels derive historically from the coalescence of vowels with intervocalic retroflex consonants (15).

(15) Historical development of retroflex vowels (Heegård & Mørch 2004)

ʂe˞a	‘blind’	< *šrēɖa-	‘slanting, squinting’
ku˞a˞k	‘little child’	< *kuɖa-	‘boy, son’
pẽ˞	‘palm of hand’	< pāɳî-	‘hand’
bõ˞	‘arrowhead, bullet’	< bāɳá-	‘arrow’

- Significantly, the vowels that occur between retroflex consonants in harmony domains are not phonemically retroflex in any of our sources. On the surface of things, this suggests that retroflexion does not permeate them (as predicted by spreading models).
- It is possible that such vowels are phonetically retroflex to some degree, but no instrumental study has yet been carried out to resolve this question.
- All things considered, the similarity effect and the phonemic status of vowels in harmony domains are more compatible with feature agreement than feature spreading.
- Further evidence for the agreement treatment of Kalasha coronal harmony comes from the fact that the language exhibits another process involving retroflexion and, unlike coronal harmony, this process is clearly compatible with the feature spreading model.
  - According to Heegård & Mørch (2004: 67-68), retroflexion optionally spreads from one vowel to another, sometimes across intervening consonants (16). Similarity does not seem to play a role in this process, as retroflexion spreads regardless of the quality of participating vowels; moreover, it can target consonants, such as the dental nasal in (16a). Retroflexion spread in Kalasha is thus inherently different from retroflex consonant harmony (cf., Hansson 2001; Rose & Walker 2004 on Vedic Sanskrit n-retroflexion).

(16)	a.	/a˗in/	[a˗in ~ a˗iⁿŋ]	‘millet’
	b.	/pi˗ik/	[pĩ˗ik ~ pĩ˗i˗k]	‘to squeeze’
	c.	/sirã˗/	[sirã˗ ~ si˗rã˗]	‘wind’
	d.	/ʦa˗ha˗ka/	[ʦa˗ha˗ka ~ ʦa˗ha˗ka˗]	‘maize bread’
	e.	/a˗ngu/	[a˗ŋgu ~ a˗ŋgu˗]	‘finger’

5. Historical sources of harmony

- Consonant harmony in Kalasha is manifested as a static morpheme structure constraint. We have found no evidence of active alternations in the synchronic grammar.
- Limited diachronic evidence concerning the source of harmony is listed in (17).

(17) Evidence of diachronic harmony in fricatives[1]

	Kalasha		**Old Indo-Aryan (i.e., Sanskrit)**	
a.	s → s			
	sastirik	‘to roof a house’	< saṁstara	‘layer of grass/leaves’
b.	s → ɕ			
	ɕiɕoa	‘handsome’	< *suśōbha-	‘splendid’
c.	s → ʂ			
	ʂuʂut, ʂuʂutr	‘ornate headband’	< *suṣūtra-	‘having fine thread’
d.	ɕ(ś) → ʂ			
	ʂiʂ	‘head, top’	< śīrṣá-	‘head, skull’
	ʂuʂik	‘to dry’	< śúṣyati	‘becomes dry’
	ʂuʂʈa	‘dry, dried’	< *śuṣṭa-	‘dried’

- The evidence in (17) is compatible with either (i) “anticipatory” right-to-left harmony and/or (ii) a trigger/target asymmetry among coronal places in which retroflexes are dominant, dentals are recessive, and palatals are intermediate (see Hansson 2001).
- We tentatively assume the dominant-recessive interpretation for the following reasons:
  - Similar dominant-recessive asymmetries occur in patterns of local coronal assimilation in Old Indo-Aryan (e.g., Sanskrit). In those cases, direction is not a factor (Whitney 1967 [1889]: 68).
  - The apparent directionality in (17) might be a by-product of the fact that word-initial retroflexes were rare at one time in Old-Indo-Aryan (Masica 1991: 157).

6. An ABC account of Kalasha coronal harmony

- We assume the standard binary place and manner features in (18), as well as laryngeal features [±voice] and [±spread] (not shown in (18)).

[1] The etymologies in (17) are based on Trail & Cooper (1999), who draw upon Morgenstierne (1973) and Turner (1966). Forms with an asterix (*) are hypothetical reconstructed forms, while all others are attested in ancient Vedic and/or Classical Sanskrit texts.

(18)

		[cor]			
		[+dist]		[–dist]	
[–son]	[–cont]	t tʰ d dɦ		ʈ ʈʰ ɖ ɖɦ	[–strid]
		ts tsʰ dz	tɕ tɕʰ dʑ dʑɦ	ʈʂ ʈʂʰ ɖʐ	[+strid]
	[+cont]	s z	ɕ ʑ	ʂ ʐ	
		[+ant]	[–ant]		

- The ABC approach (Walker 2000; Rose & Walker 2004; Hansson 2001; Hansson 2007) captures properties of consonant harmony systems using a set of Correspondence C↔C constraints, CC Faithfulness constraints, and the traditional I/O Faithfulness constraints.
- Correspondence C↔C constraints impose a correspondence relation on two featurally similar segments co-occurring in an output string.

(19) Corr-T↔Ṭ: any two coronal obstruents ([cor, ±son]) that have the same specifications for [±strid, ±cont] (regardless of differences in [±voi, ±spread, ±ant, ±dist]) are correspondents of one another.

- Correspondence C↔C constraints that involve less similar segments are ranked below Corr-T↔Ṭ.

(20) a. Corr-Č↔Ṣ: any two coronal obstruents ([cor, ±son]) that have the same specifications for [±strid] (regardless of differences in [±cont, ±spread, ±voi, ±ant, ±dist]) are correspondents of one another.

b. Corr-T↔Ḉ: any two coronal obstruents ([cor, ±son]) that have the same specifications for [±cont] (regardless of differences in [±strid, ±voi, ±spread, ±ant, ±dist]) are correspondents of one another.

c. Corr-T↔Ṣ: any two coronal obstruents ([cor, ±son]) (regardless of differences in [±cont, ±strid, ±voi, ±spread, ±ant, ±dist]) are correspondents of one another.

(21) Similarity-based correspondence hierarchy for [±distributed] in coronal obstruents

Corr-T↔Ṭ	»	Corr-Č↔Ṣ, Corr-T↔ Ḉ	»	Corr-T↔Ṣ
same manner		*same stridency* *same continuancy*		*same soronancy*

- CC Faithfulness constraints require structural identity of the segments in a correspondence relation. Together with IO Faithfulness constraints, they are part of the consonantal correspondence model (22).

(22) Consonantal correspondence model (Rose & Walker 2004: 492)

Input /t a ʈ/

⇳ IO Faithfulness

Output [t a ʈ]

⇖ ⇗

CC Faithfulness

- The ranking of CC Faithfulness over IO Faithfulness (and Correspondence C↔C) ensures the application of harmony. The ranking of Ident-IO[-dist] over Ident-IO[+dist] ensures that retroflexes are triggers of harmony, while non-retroflexes are targets.

(23) a. Ident-CC [±dist]: segments within a string that are correspondents of one another must have the same value for [±distributed].
b. Ident-IO [-dist]: segments specified for [-dist] in the input must have the same feature value in the output.
c. Ident-IO [+dist]: segments specified for [+dist] in the input have to have the same feature value in the output.

(24) Retroflex harmony applies in same-manner combinations: two stops

	/taṭ/	Id-CC [±dist]	Corr-T↔Ṭ	Id-IO [–dist]	Id-IO [+dist]	Corr-Č↔Ṣ	Corr-T↔Ç
a.	$t_x a t_y$		*!			*	*
b.	$t_x a t_x$	*!					
c. ☞	$ṭ_x a t_x$				*		
d.	$t_x a t_x$			*!			

(25) Retroflex harmony does not apply in different-manner combinations (e.g., stop/affricate)

	/tsaṭ/	Id-CC [±dist]	Corr-T↔Ṭ	Id-IO [–dist]	Id-IO [+dist]	Corr-Č↔Ṣ	Corr-T↔Ç
a. ☞	$ts_x a t_y$						*
b.	$ts_x a t_x$	*!					
c.	$ṭs_x a t_x$				*		
d.	$ts_x a t_x$			*!			

- The addition of posteriority harmony can be formally implemented by adding relevant CC Faithfulness and IO Faithfulness constraints on features [+ant] and [-ant]:

(26) Posteriority harmony in same-manner combinations (e.g., fricative/fricative)

	/saç/	Id-CC [±dist]	Id-CC ([±ant])	Corr-T↔Ṭ	Id-IO [–dist]	Id-IO [–ant]	Id-IO [+dist]	Id-IO [+ant]
a.	$s_x a ç_y$			*!				
b.	$s_x a ç_x$		*!					
c. ☞	$ç_x a ç_x$							*
d.	$s_x a s_x$					*!		

- In sum, the proposed ABC analysis successfully accounts for the key facts of coronal harmony in Kalasha, a pattern that is sensitive to the similarity of participating segments.

8. Conclusion

- Our study of Kalasha reveals a robust pattern of retroflex harmony, or coronal place harmony more generally, that is sensitive to the relative similarity of coronal obstruents in terms of their manner of articulation.
- To the best of our knowledge, no pattern of this kind has been reported for any language in the literature on retroflex consonant harmony. Thus, the study makes an important empirical contribution to the field.
- We suggest that the similarity effect in Kalasha, and the phonemic non-retroflex status of vowels in harmony domains, are both more compatible with the typology and predictions of the ABC model than with those of feature spreading models.
- A phonetic study of the vowels in harmony domains might shed further light on the mechanisms of consonant harmony.

Selected References

Bashir, Elena. 2003. Dardic. In The Indo-Aryan languages, ed. George Cardona and Dhanesh Jain, 818–894. London and New York: Routledge.

Breeze, M. J. 1990. A sketch of the phonology and grammar of Gimira (Benchnon). In Omotic language studies, ed. R. J. Hayward, 1–67. School of Oriental and African Studies, University of London.

Frisch, Stefan A., Janet B. Pierrehumbert, and Michael B. Broe. 2004. Similarity avoidance and the OCP. Natural Language and Linguistic Theory 22: 179–228.

Gafos, Adamantios I. 1999. The articulatory basis of locality in phonology. New York & London: Garland Publishing.

Hansson, Gunnar Ólafur. 2001. Theoretical and typological issues in consonant harmony. Doctoral dissertation, University of California, Berkeley.

Heegård, Jan, and Ida Elisabeth Mørch. 2004. Retroflex vowels and other peculiarities in the Kalasha sound system. In Himalayan languages, past and present, ed. Anju Saxena, 57–76. Berlin and New York: Mouton de Gruyter.

Maddieson, Ian, and Kristin Precoda. 1992. UPSID and PHONEME (version 1.1). University of California at Los Angeles.

Mahapatra, B.P. 1979. Malto: an ethnosemantic study. Mysore: Central Institute of Indian Languages.

Masica, Colin P. 1991. The Indo-Aryan languages. Cambridge: Cambridge University Press.

Morgenstierne, Georg. 1973. Indo-Iranian frontier languages, Vol. 4, The Kalasha language. Oslo: Universitetsforlaget.

Mørch, Ida Elisabeth and Jan Heegård. 1997. Retroflekse vokalers oprindelse i kalashamon i historisk og areallingvistisk perspektiv [The origin of retroflex vowels in Kalashamon in a historical and areal linguistic perspective]. MA thesis, University of Copenhagen.

Rose, Sharon and Rachel Walker 2004. A typology of consonant agreement as correspondence. Language 80: 475–531.

Shaw, Patricia A. 1991. Consonant harmony systems: the special status of coronal harmony. In Phonetics and phonology, Vol. 2, The special status of coronals: internal and external evidence, ed. Carole Paradis and Jean-François Prunet, 125–157. San Diego: Academic Press.

Trail, Ronald L. and Gregory R. Cooper. 1999. Kalasha dictionary – with English and Urdu. Islamabad: National Institute of Pakistan Studies and Summer Institute of Linguistics.

Turner, R. L. 1966. A comparative dictionary of Indo-Aryan languages. London: Oxford University Press.

Whitney, W. D. 1967 [1889]. Sanskrit grammar. Cambridge, Mass.: Harvard University Press.