Consonant Harmony in Karaim[1]

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1. Introduction

A growing body of recent work asserts that consonant harmony is either limited to child language, coronal consonants (Rialland and Djamouri 1984, Ní Chiosáin and Padgett 1993, 2001, Flemming 1996, Gafos 1999, Baković 2000, Pierrehumbert 2000, Krämer 2001, McCarthy 1998, 2002), or is impossible (Archangeli and Pulleyblank 1994). Gafos attributes this restriction on consonant harmony to *articulatory contiguity* (the units of which are phonetic gestures), whereby "the vowel gestures are contiguous in a VCV sequence but consonant gestures are not contiguous in a CVC sequence" (1999:41). If one assumes that all phonological processes are strictly local, and that the correct notion of locality in phonology is articulatory contiguity, as Gafos suggests, then the logical consequence is that "phonological spreading…could not be involved between the two consonants of a CVC configuration…because the vowel interrupts the articulatory contiguity between the two consonants" (Gafos 1999:41).

In order to test the predictions of this theory, henceforth referred to as Strict Locality, we analyze the system of consonantal harmony involving the feature [back] in the Northwest dialect of the Turkic language Karaim. We demonstrate that neither this system nor the behavior of consonant harmony cross-linguistically can be insightfully accounted for in the surface-phonetics theory espoused by the proponents of Strict Locality. We establish moreover that Optimality Theory, in which all constraints on representations are violable, is at odds by its very nature with an inviolable principle of Strict Locality. We argue that phonological spreading is constrained instead by a more abstract principle, *Relativized Locality*, in which constraints on the locality of phonological operations are defined on autosegmental tiers that may (systematically) ignore certain features (cf. Clements and Sezer 1982, Odden 1994, Calabrese 1995, Halle, Vaux, and Wolfe 2000, and most pre-OT treatments of harmony).

[1] We are greatly indebted to Eva Csató and David Nathan for providing us with their excellent CD-ROM, *Spoken Karaim*, on which the phonetic details of our analysis are based. For consistency we have converted into IPA the various transcription systems employed by authors who have treated Karaim. Our transcription of Csató and Nathan's recordings are based directly on the sound files rather than on their transcriptions; for all other transcriptions, an equivalency table is provided in Appendix I at the end of this paper. We would like to thank Jonathan Barnes, David Braun, Morris Halle, Jonathan Kaye, and Donca Steriade for helpful comments on earlier versions of this paper.

1.1 Historical preliminaries

Karaim (also sometimes called Karaite), a member of the Kipchak subgroup of the Turkic language family, which also includes Kipchak, Karachay, Crimean Tatar, and Kumyk, is spoken by a small Crimean community whose religious beliefs are traced back to a branch of Judaism which, in the 8th century, rejected the Talmud and pursued a doctrine of *sola scriptura*. Located for more than six hundred years along the eastern border of the one-time Polish kingdom (now split between Poland, Lithuania, and the Ukraine) (Csató 1997), it appears that they were spared the fate of other Jewish communities in Eastern Europe during World War II because the Nazis did not identify them as Jewish. Tadeusz Kowalski, a Polish linguist writing in German in 1929, and the foremost seconday source on Karaim, states that "only five [communities] have survived to the present day…in Poniewież (Karaim Pon'ev'ež), Troki, Wilno, Łuck, and Halicz. The colony of Poniewież is now in Lithuania; the remaining four are in Poland. The largest and strongest is the colony of Troki (actually Nowe Troki, Karaim Troχ), a small city" (1929:vi).[2]

Regarding the present sociolinguistic situation, Csató 1997 observes that "due to political measures taken by the post-war Soviet regime, the communities are now dispersed and the maintenance of their language has become endangered. The number of Karaims in Lithuania is about two hundred, but only a fourth of them, mostly members of the eldest generation, still have a communicative competence in the language. In the Ukraine, the number of Karaim speakers is not more than six." Due to the contributions of recent efforts by Eva Csató and Yuni Kim & David Mihalyfy to record the current state of this endangered language and document its ethnomusicological traditions, we have the good fortune to have primary audio recordings of several Karaim speakers (see especially Csató and Nathan 2002) that can be used to verify and build on the detailed grammatical description by Kowalski.

Karaim is traditionally divided into three dialects (Csató 1997): *Eastern*, spoken in the Crimea up to the beginning of the twentieth century but now apparently extinct; *Northwestern*, spoken in Lithuania, sometimes called the Troki or Trakai dialect; and *Southwestern*, now spoken only in the aforementioned town of Halicz in the Galicia region of the Ukraine. Kowalski 1929 states that only the Northwestern dialect displays the particular form of consonant harmony in which we are interested; this also happens to be the form recorded by Csató/Nathan and Kim/Mihalyfy, and the form on which we focus here.

2. The facts

2.1 Fundamentals of Karaim phonology

Northwest Karaim features the inventory of eight surface vowels in (1):

[2] All quotations from Kowalski 1929 have been translated from German by the authors.

(1) surface vowel inventory (Kowalski 1929)

	[-back]		[+back]	
	[-round]	[+round]	[-round]	[+round]
[+high]	i	(y)	(ɯ)	u
[-high]	(e)	(ø)	ɑ	o

Kowalski notes that the parenthesized vowels in (1) are distributionally restricted:

(2) distributional restrictions on Karaim vowels

(i) [ɑ] contrasts with [e] *only in initial syllables*—elsewhere only [ɑ] occurs. The contrast in initial syllables can be seen in $t^{h}ɑv$ 'mountain' vs. el^{j} 'hand' in (3), and the neutralization in non-initial syllables can be seen in forms such as Karaim el^{j}-$d^{j}ɑn^{j}$ 'hand-ABLATIVE' (cf. Turkish el-den).

(ii) The front round vowels {y ø} surface *only in word-initial position* (e.g. $øz^{j}ɑn^{j}$ 'river', $yv^{j}ɾ^{j}ɑt^{j}$ 'study')—elsewhere only their back counterparts {u o} appear where in other Turkic languages we have {y ø} (e.g. Karaim $k^{hj}u̲n^{j}$ 'day' vs. Turkish gün).

(iii) Underlying (as well as historical) /ɯ/ *cannot surface in word-initial position*, and merges here with /i/ as [i], regardless of the harmonic polarity of the word in question—cf. $imɯɾt^{h}χɑ$ 'egg' (Kowalski 1929:81; expected *$ɯmɯɾt^{h}χɑ$) vs. Turkish yumurta. This latter form, as well as forms like iɾ 'song' show that words with "original" (in the underlying representation, or historical) *ɯ show [+back] harmony, not the [-back] value one might expect from the surface featural complement of [i]. This is particularly clear with the plural of 'song', which is iɾ-łɑɾ, not *$iɾ^{j}l^{j}ɑɾ^{j}$.

Abstracting away from (2), the basic generalization concerning Northwest Karaim vowels is that front-back pairs contrast only in initial syllables. The lone exception is the high unrounded pair i ~ ɯ, which as shown for the genitive /-NIN/ in (3) *does* contrast in non-initial syllables.

(3)

stem	**genitive**	**gloss**	
$t^{h}ɑv$	$t^{h}ɑv$-nɯn	mountain	(cf. Tk. dağ-ın)
el^{j}	el^{j}-$n^{j}in^{j}$	hand	(cf. Tk. el-nin)

Turning to the consonants, most have [+back] and [-back] versions (/t/ and /t^{j}/, etc.), as in the ambient languages Russian and Polish; see Appendix 1 for the complete inventory. The only exceptions to this generalization are p and r, which according to Kowalski normally have no palatalized version in syllable-final position (cf. $k^{hj}op(^{j})$ 'very' in (6)).

As in many other Turkic languages, including most non-standard dialects of Turkish, the front-back contrast with dorsal stops is reinforced by a

contrast in continuancy: as can be seen in (4) (Kowalski 1929:37), [-back] k surfaces as a stop, [k^{hj}], but its [+back] equivalent surfaces as a fricative, [χ].

(4)	**suffix**	**root**	**surface form**	**gloss**
a.	/-mɑK/[3]	bɑr 'go'	bɑrmɑχ	go-INFINITIVE
		$k^{hj}or^{j}$ 'see'	$k^{hj}or^{j}mɑk^{hj}$	see-INFINITIVE
b.	/-KɑN/	ɑt 'shoot'	at-χan	shoot-PARTICIPLE
		$k^{hj}et^{hj}$ 'go'	$k^{hj}et^{hj}$-$k^{hj}ɑn^{j}$	go-PARTICIPLE

2.2 Consonant harmony

The Northwest dialect of Karaim shares with most other Turkic languages the property of spreading the feature [back] within phonological words, but differs insofar as the harmonic feature generally surfaces on *consonants* rather than *vowels*. In Northwest Karaim, root and suffixal consonants agree in backness with the first root consonant that contrasts for backness,[4] *regardless of the quality of intervening vowels*. Representative alternations for the plural /-LɑR-/ and the ablative /-DɑN-/ are given in (5-6), and a form showing long-distance multiple propagation of [back] in (7) (Kowalski 1929):

(5) a. $k^{h}uŋ$-łɑr-dɑn servant-PL.-ABL. (cf. Turkish kul-lar-dan)

b. $k^{hj}un^{j}$-$lɑr^{j}$-$d^{j}ɑn^{j}$ day-PL.-ABL. (cf. Turkish gün-ler-den)

(6)

stem	**ablative**	**gloss**	
suv	suv-dɑn	water	(cf. Tk. su-dan)
$k^{hj}un^{j}$	$k^{hj}un^{j}$-$d^{j}ɑn^{j}$	day	(cf. Tk. gün-den)
$t^{h}ɑʃ$	$t^{h}ɑʃ$-$t^{h}ɑn$	stone	(cf. Tk. taş-tan)
$m^{j}en^{j}$	$m^{j}en^{j}$-$d^{j}ɑn^{j}$	I	(cf. Tk. ben-den)
$k^{hj}op(^{j})$	$k^{hj}op(^{j})$-$t^{hj}ɑn^{j}$	very	(cf. Tk. çok-tan)

(7) $t^{h}or^{j}ɑ$-$s^{j}iz^{j}$-$l^{j}ig^{j}$-im[^{j}]-d[^{j}]$ɑn^{j}$ 'from my injustice'[5] (Kowalski 1929:69)

Parallel alternations can be seen in the deverbal suffix /-V/ (8a) and the subject participle /-GAN/ (8b):

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[3] Capital letters denote phonemes that alternate for the feature [back] in surface forms.

[4] The contrast clause is essential here, because /j/, which is not contrastive for [back], does not propagate its [back] specification; cf. joł 'road' (Kowalski 1929:108).

[5] The m and d are presumably palatalized in this form; Kowalski's typesetter is inconsistent in including the apostrophe that denotes palatalization in his work. (His errors, however, appear to be only of omission, not comission.)

(8) suffix alternations

a. deverbal /-V/ → [v, vʲ, uv, uvʲ] (Kowalski 1929:33, 108)
kʰʲelʲ-uvʲ ‘arrival’
ɑtʃ-uv ‘anger’
tʃʲorgʲɑ-vʲ ‘belt, sleeve’
tʰʲuzʲu-vʲ-tʃʲu-dʲɑnʲ ‘from the author’ (create-DEVERB-AGENT-ABL)
boł-uʃ-uv-tʃu ‘helper’ (help-VERBAL.SUFFIX-DEVERB-AGENT)

b. /-GaN/ ‘subject participle’ (Kowalski 1929:44, 61)
ølʲ-gʲɑnʲ ‘dead’
kʰʲomʲul-gʲɑnʲ ‘buried’
ølʲ-umʲ-unʲ-dʲɑ ‘in his death’ (underlying /øl-IM-IN-Dɑ/)

Note that non-initial /a o u/ are *transparent* to consonant harmony *even though they have front counterparts*, which, as we have seen, surface in initial syllables. This fact will become important when we consider the claims of Strict Locality in section 3.

We can formulate the rule responsible for the alternations in (5-8) as follows:

(9) Spread contrastive [back] specifications L → R within a word.

In this analysis, the [back] specifications of intervening vowels are ignored, since they are not contrastive (Calabrese 1995). In Relativized Locality, a syntagmatic process of spreading can be sensitive not only to the *type* of intervening features, but the *values* as well.

The derivation of ‘day-ABLATIVE’ would therefore be as follows:

(10) a. underlying form /kʲ u n d ɑ n/
|
[-back]

b. rule (7) kʲ u n d ɑ n
[-back]

c. surface form [kʲ u nʲ dʲ ɑ nʲ]

2.3 Origins of Karaim consonant harmony

Consonant harmony of the sort just described is relatively rare (though it can be found in more limited form in several other Turkic languages), and, as mentioned earlier, is problematic for many phonological theories. How then might such a system have arisen? Kowalski attributes the change to the neutralizations that took place in the vowel system, with a concomitant shift of the [back] contrasts from those vowels to the neighboring consonants: “as a result of the above vowel shift, the original vowel harmony is destroyed; and in its place there appears a kind of consonant harmony in that inside a sound group

(a word) only hard (nonpalatalized) or only soft (palatalized) consonants are admitted. We thus have, e.g., k'un'l'ardan' 'from the days next' to kuŋlardan 'from the servants' [cf. (5)]. The vowels in the two words are identical; the consonants, however, are palatalized in the former case, and not palatalized in the latter case. In place of two contrasting vowel series we have in Northwest Karaim two contrasting consonant series. The appearance of harmony has thus been transferred from the domain of the vocalism into that of the consonantism." (1929:30). He adds that "this phenomenon is unique in the Turkic languages, to the best of my knowledge…in the Turkic languages, we find in Gagauz (cf. V. Moškov, Proben der Volksliteratur der türkischen Stämme, X, p. xxvii) a clear palatalization of all consonants under the influence of front vowels, without change in the nature of these vowels. One can therefore say that in Gagauz both vowel harmony and consonant harmony exist simultaneously next to one another. Northwest Karaim takes one further step in that it gives up vowel harmony in favor of consonant harmony."

Comrie (1981:63) frames this scheme in slightly more contemporary terms: "although the distinction palatalised versus velarised consonants is in general less salient phonetically than that between front and back vowels, and can therefore be considered purely allophonic, there are some Turkic languages where the distinction has shifted from the vowels to the consonants, so that one has a tendency towards consonant harmony rather than vowel harmony. In both Gagauz and Karaim, front vowels are backed after a palatalised consonant, so that in Karaim we have k'oz'um'd'a for expected közümde 'in my eye' and öz'an' for expected özen 'stream'. It will be seen from these examples that the front-back distinction is not carried completely by consonants: words with an initial vowel still retain initial front, including front, rounded vowels, since the backing takes place as a historical process only after consonants."

Hamp 1976 then observes that the historical change involved here is actually quite simple in formal terms: "It seems clear that the mechanism of vowel harmony in these languages has been the factor which has facilitated or at least permitted at small cost the structural shift of vowel quality into consonantism that we observe. That is to say, for an earlier vowel harmony we find consonant harmony, but with the form of the phonological rule changed in little detail…Now, I would formulate what has happened in Karaite as being a change in the composition of the harmony rule whereby [α front] has been transferred from the [-cons] to the [+cons] segments of the word. In its mechanism the rule change seems to be as simple as that; and that simplicity is what permitted it perhaps to be so pervasive. After that of course, the vowels simply neutralize."

In sum, there appears to be a plausible historical scenario by which consonant harmony of the Karaim type can develop, which can be summarized in terms of the following stages:

(11) stages in the development of Northwest Karaim consonant harmony

stage	system	schematic
i	vowels contrast phonemically for [±back]	CɑCɑC, CeCeC
ii	adjacent consonants come to share the [back] values of these vowels via coarticulation (perhaps later phonologized as a spreading rule)	UR: /CɑCAC/, /CeCAC/ SR: [CɑCɑC], [C^{j}eC^{j}eC^{j}]
iii	surface [back] values that appear on both consonants and vowels are reinterpreted as being specified underlyingly for the consonants, but not the vowels; spreading/coarticulation still active. (This stage presumably happened after the Karaites became bilingual in Slavic languages wherein [back] contrasts were phonemic for consonants.)	UR: /CACAC/, /C^{j}ACAC/ SR: [CɑCɑC], [C^{j}eC^{j}eC^{j}]
iv	deletion of rule spreading consonants' [back] values to adjacent vowels (formally: addition of [+cons] to target of the spreading rule)	UR: /CACAC/, /C^{j}ACAC/ SR: [CɑCɑC], [C^{j}ɑC^{j}ɑC^{j}]

3. Analysis

Though the facts outlined in section 2 thus find a plausible historical explanation, their synchronic analysis poses a problem for the widely-held belief that all phonological operations are local, i.e. apply only to adjacent elements. The problem is that (with the exception of i/ɯ) Karaim appears to spread [back] values from consonant to consonant, ignoring intervening vowels. In this section we survey and contrast the two leading theories of phonological locality, and compare how these bear on the Karaim facts and vice versa.

3.1 Karaim displays nonlocal harmony

Let us begin by defining Locality as follows:

(12) LOCALITY: Two elements A and B are *local* if there is no element C of type T that intervenes between A and B

Two interpretations of (12) have been favored in the phonological literature since the development of autosegmental phonology, Relativized Locality (13a) and Strict Locality (13b). Strict Locality (Ní Chiosáin and Padgett 1993, 1997, Gafos 1999, etc.) maintains that no material of any sort may intervene between the trigger and target of a phonological operation; in other words, no relation (such as spreading or feature movement) can be established across a phoneme P without P participating in that relation. In terms of the definition in (12), "type T" is specified for Strict Locality as the phoneme (or root node). *Relativized*

Locality (Goldsmith 1976, Clements 1976, Kiparsky 1981, Clements and Sezer 1982, Steriade 1987, 1995, Odden 1994, Calabrese 1995, etc.) requires only that the trigger and target be adjacent on a specified autosegmental tier, such as the [back] tier; intervening material can be ignored so long as it is not specified for the variable in question. In terms of (12), Relativized Locality involves a *dependent instantiation* of Type T; T can be specified as vowel, consonant, sonorant, A position, A' position, and so on.

Strict Locality requires spreading of a feature F to apply not only to the desired target X, but also to all intervening elements BCD, as schematized in (13b). Relativized Locality on the other hand allows skipping of BCD, provided they are not legitimate targets of the spreading operation (13a). To take a concrete example, a classic case of vowel harmony for the feature [round] would set (13) with the values X = vowel, F = [round], ABCD = consonants. In such a case Strict Locality would require that the rounding harmony operation spread [round] to all of the consonants as well as the vowels, whereas Relativized Locality would allow intervening consonants to be skipped.

(13)

a. A X B C X D X
[F]

b. A X B C X D X
[F]

where X= a legitimate target for the feature [F]

Why would one want to advocate Strict Locality rather than Relativized Locality, given that in rounding harmony for example intervening consonants do not appear to become rounded? The initial impetus was to account for the putative universal that the only attested (and hence possible) sort of consonant harmony involves coronal features: "the spreading of single C-Place features (major articulations) to nonadjacent consonants appears to be restricted to [coronal], and in all known cases of [coronal] spreading, the target must also be [coronal]" (Clements and Hume 1995:305). Flemming 1996 accounts for this generalization by pointing out that "the only consonantal gestures which can be extended through a vowel without significantly affecting its quality are the differences in tongue-tip posture that can distinguish coronals". Gafos 1999 attributes this generalization to a version of Strict Locality that requires articulatory contiguity, as we saw earlier.

Karaim Consonant Harmony clearly constitutes a direct challenge to this empirical generalization, and hence to the entire concept of Strict Locality, as it seems to involve spreading of [back] values from consonant to consonant without affecting intervening vowels, thus presenting a case of type (13a), and precisely the sort of case explicitly ruled out by Clements and Hume, Flemming, and Gafos. Ní Chiosáin and Padgett 2001 and the other proponents of Strict Locality would claim that in (some) cases of this type the consonantal [back] specifications spread to the intervening vowels, but the vocalic [back] differences are not noticed by native speakers or linguists because they are not contrastive (cf. Gordon 1999 on Finnish [back] harmony). We provide direct spectrographic evidence against this position in Section 4.

3.2 Consonant Harmony: Analysis

As Karaim consonant harmony spreads from roots to suffixes, it must be the case that the specification for [back] is on the root and not the suffix, and that spreading occurs from left to right. Moreover, as evidenced by the form imɯɾtχɑ 'egg' (2iii), it cannot be the case that the value of [back] spreads from the initial *segment* to all eligible rightward segments. In addition, as evidenced by joł 'road' (fn. 4), it cannot be the case that the value of [back] spreads from the initial *consonant* to all eligible rightward segments. Therefore, following Kowalski's descriptive characterization that Karaim *words* are back or front, and the modern autosegmental implementation of Turkish harmony in Clements and Sezer 1982, the best analysis of Karaim is that the *root morpheme* is specified as [+back] or [-back].

Through Kowalski's careful description, auditory inspection (that the reader is invited to confirm; see fn. 13), and acoustic analysis of the second formant (F_2, the acoustic correlate of the feature [back]), it emerges that the following phenomena must be accounted for:

(14)

a. Palatalization of consonants is categorical

b. The fronting of non-initial [a, u, o] is *not* categorical (but may occur as a coarticulatory effect in phonetic implementation, influenced by such factors as duration and flanking by two palatalized consonants). The distribution of vowels (no initial ɯ, no non-initial ø, y, e) must be explained, either by phonologization or positional faithfulness/markedness.

c. The fronting of [y] is categorical.[6]

Consider briefly an analysis in which [-back] spreading is all just one "ungapped" "gesture": there will be no way to explain the difference in categorical assimilation in the case of ɯ/i but only gradient centralization in [a o u]. Before proceeding to the representation that we favor in modeling Karaim, there is a didactic point, perhaps obvious, that must be made:

(15) The issue of non-local relations between elements in a representation is completely separate from that of derivational versus parallel computation.

Because our ultimate goal here is to argue against the strict locality fallacy, we will present both a traditional spreading analysis and a penalty-minimization analysis.

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[6] One possibility, suggested by Donca Steriade, is that ɯ does not alternate with [i] at all in the *phonology*, but is simply the most susceptible to coarticulation, due its status as the shortest duration vowel (well-noted for high unrounded vowels, as evidenced in Japanese); see Shademan 2003 on the relationship between duration and susceptibility to categorical assimilation.

(16) Spreading analysis[7]

(i) There are four underlying vowels in Karaim: /o u a y/ (two round, two low, no back contrast).

(ii) Consonants (besides /j/) are underlyingly [+back]

(iii) The root of the word, w, is either [+back] or [-back]

A) If root.[back] = minus:
$\forall x \in$ w, consonant(x):
Let x.[back] = minus
If $\exists x \in$ w, vowel(x) & precedes(#,x):
Let x.[back] = minus
If $\exists x \in$ w, syllable(x) & precedes(#,x) & $\exists y$, y = /a/ & nucleus(x,y):
Let y.[back] = minus

B) Elsewhere:
If $\exists x \in$ w, x = /Y/ & precedes(#,x):
Let x.[back] = minus

It is important to note that there is no extrinsic ordering in (16); all structural changes are enacted when their structural descriptions are satisfied, as ordered by the Elsewhere Condition.

(17) A Static AGREE analysis in Optimality Theory:

(i) Three positional markedness constraints:[8]
*[-back,+round] in non-initial position
*e in non-initial syllables (except in loans)
*ɯ/ #_

(ii) All of the constraints in (i) outrank $\text{AGREE}_{[\text{-back}]}$: Assess a violation when a segment does not bear [-back] and the first consonant is [-back]

(iii) $\text{AGREE}_{[\text{-back}]}$ outranks $\text{IDENT-IO}_{[\text{-back}]}$ (which, due to the nature of the input, must always be violated once)

An illustrative tableau is provided in (18) (where * denotes a violation and ✌ denotes the optimal output):

[7] Models which substitute the privative element "I" (Kaye, Lowenstamm, and Vergnaud 1985 et seq.) for all instances of [-back] herein are equivalent for present purposes.

[8] There is no combination of positional *faithfulness* constraints that can ensure the Karaim pattern.

(18)

Input: /{-back}KomuL+gan/	*[-bk,+rd]	*e in $\sigma_{n>1}$	AGREE$_{[-bk]}$	IDENT-IO$_{[-bk]}$
kʲomułgan			!*******	
☞kʲomʲulgʲanʲ			***	*****
kʲømʲylgʲanʲ	!*		*	*******
kʲomʲulgʲenʲ		!*	**	******

It is worth mentioning that we view the structural changes to initial vowels (or, the positional markedness constraints on non-initial vowels) as statements in the synchronic grammar, allowable within the representational limits of Universal Grammar. However, their diachronic source is worth speculating upon. Pursuing the "Today's Errors are Tomorrow's Rules" view (Ohala 1981), it is quite likely that the proto-Turkic 9-vowel system was reinterpreted as secondary articulations on the surrounding consonants. Kochetov 2002 presents an agent-based simulation for this sort of change; compare also Colarusso's (1992:28) description of the origins of the Kabardian vowel system: "The two-vowel system of Kabardian has arisen by a historical process in which the normal vowel colorings of the syllable peak have been reinterpreted as belonging to the consonants and glides of the syllable margins. Only +low cannot be reinterpreted, and so the process stopped at two vowels."

Following Barnes 2003, it may be that absolute initial vowels are significantly lengthened in duration, leading to a greater inventory of contrasts including {y, ø}. In addition, proto-Turkic had initial stress (Poppe 1960), which may have led to a greater inventory of contrasts (including e). Though only hypothetical at this point, such a series of events may have led to the synchronic positional distribution of vowel contrasts.

3.3 Why is everything violable except locality?

It should be noted that the very notion of Strict Locality runs counter to the central OT tenet of Violability. Why should it be the case that all of the constraints provided by Universal Grammar are violable (McCarthy and Prince 1993:144-5), but this one principle is inviolate? Such a constraint would have to be implemented as a meta-constraint on GEN, which is redundant, since GEN + the set of universal violable constraints is already designed to generate all and only the possible human grammars. In order to depart from this central tenet of Optimality Theory one would need strong evidence that Strict Locality holds over all possible human languages but does not follow from the activity of GEN + the universal constraint set. In fact, though, there are many well-known examples of precisely the sorts of phenomena predicted to be impossible by Strict Locality (see Vaux 1999 and Hansson 2001 for detailed surveys).

The proponents of Strict Locality have taken note of several such cases, and have argued each to involve some other principle that doesn't have to obey locality. For instance, Gafos 1998 claims that consonant spreading in Semitic, which is irreducibly non-local, involves reduplication rather than spreading, even though there is no morpheme of which the putative reduplication is the

exponent. He asks "why spreading in a V/C planar segregate CV sequence spreads the whole consonant and nothing less than that" (1998:230). We respond that two or more articulator-free features assimilate together only in cases of total assimilation (McCarthy 1988). Gafos' flabbergastedness at spreading that involves an entire set of features (rather than an arbitrary subset) is precisely one of the *limited* options within a quantificational approach to structural descriptions (see Reiss 2003, Nevins (to appear) for discussion) which, in this particular domain, only allows single-feature (existential) or all-features-of-a-subclass (universal) quantification, just as it allows single-target assimilation or entire-domain vowel harmony, but not "exactly three nuclei long" spans of vowel harmony.

Bantu nasal harmony, which spreads nasality through intervening consonants without nasalizing some of them (Ao 1991, Odden 1994), is claimed by Walker 1999 to involve Correspondence rather than spreading. It does not matter what one calls this structural relationship; the point is that it is nonlocal. Ní Chiosáin and Padgett (2001:50, 54) argue that anything that looks nonlocal involves covert intermediate representational stages. Regarding transparent vowels in vowel harmony systems, for example, they propose that "transparent vowels actually undergo harmony at an abstract level of representation; however, the offending feature cannot appear at the surface…another mapping to a final output is required".

In addition to undermining the OT notions of Violability and (in the case of Ní Chiosáin and Padgett 2001) Monostratalism, and duplicating an effect that is supposed to be achieved by GEN, the individual solutions fail to extend to the general case (e.g. Gafos' reduplication analysis of Semitic cannot extend to Bantu) and do not mesh well with our understanding of locality in other linguistic domains. In syntax, for instance, would anyone propose (analogous to Ní Chiosáin and Padgett 2001) that a *wh-* phrase moves through *every* XP and then its traces are deleted from all *non*-A' positions afterwards? We prefer to understand phonological locality in manner parallel to that espoused for syntax by Rizzi 1990: "a fundamental core of syntactic processes are bound to apply in local domains…[one way to investigate this] is to assume that the process cannot apply across an intervening element of the *designated* kind, which could in principle be involved in the process".

4. Phonetic analysis

Even if our readers are nonplussed by the fact that Strict Locality is of extremely limited generality, and requires a host of parochial additions for each counterexample to its theoretical predictions, we demonstrate an empirical problem for the weaker thesis that intervening segments are affected by spreading processes, a variant of which has been proposed by Csató and Johanson 1995 and Csató 1997, 1999 and for Northwest Karaim. They state that, contrary to Kowalski's generalization, the Northwest Karaim vowels *do* alternate for backness, just as in the other Turkic languages. Thus, for example, she renders Kowalski's <üč'un'> (IPA [ytʃ^{j}un^{j}]) 'because' as <üč'ụn'>, with <ụ> denoting a high central rounded vowel; the second vowel is central rather

than back because it has been fronted by the harmony process.[9] The same holds for Csató and Nathan's transcriptions of the recordings on the Spoken Karaim Project CD, as exemplified in (19):

(19)	**Csató/Nathan**	**Kowalski-an**	**gloss**	**IPA**[10]
	t'ụz'ụm'ạ	t'uz'u-m'a	restore-INF	$t^{hj}uz^{j}um^{j}a$
	s'ụv'ạr'lạr	s'uv'-ar'-lar'	lovers	$s^{j}uv^{j}a\text{ɾ}^{j}\text{ɪ}l^{j}a\text{ɾ}^{j}\text{ɪ}$
	č'ọp'r'ạn'i	č'op'r'a-n'i	yeast-ACC	$\text{ʧ}^{j}op^{j}\text{ɾ}^{j}an^{j}i$

Csató's interpretation in her various publications conforms closely to Gordon's 1999 analysis of Finnish /i/, which is traditionally believed to be transparent to [back] harmony but he has argued to be more back in [+back] spans than in [-back] spans.

Should we therefore conclude that Kowalski's hearing was faulty? There are several reasons to believe that it was not. First, mishearings typically err in the direction of what one *expects* to hear, not what one does *not* expect to hear. This is the case for example with early turcologists transcribing Mongolic and Tungusic vowel systems with the [back] contrasts they expected to hear on the basis of the Turkic languages. It was not until the 1980s, when careful phonetic study of these languages became possible, that they were shown to actually employ [atr] rather than [back] contrasts (Rialland and Djamouri 1984, Svantesson 1985). The normal state of affairs in Turkic languages is for vowels to show [+back] and [-back] alternants, so we expect a seasoned turcologist like Kowalski to notice such alternations if they actually exist. In fact, he goes out of his way to specify that the vowels do *not* alternate. Since the Northwest Karaim system as described by Kowalski represents a *departure* from the backness system that turcologists would expect, it seems reasonable to assume that he had good reason to depart from the expected.[11]

Second, one cannot argue that Kowalski was unable to hear the relevant vowel contrasts or was unfamiliar with the concept of vowel harmony and therefore did not notice it. Kowalski noted the existence of vowel harmony and the problematic non-initial vowels (e, ø, y) for the *other* dialects of Karaim, in the very same book (1929) wherein he observed that Northwest Karaim lacked these.

Third, Kowalski notes the relevant vowel contrasts (a:e, o:ø, u:y) within Northwest Karaim in initial syllables. It thus does not make sense to claim that he was unable to hear these contrasts in non-initial syllables with the same speakers. This is especially true for final syllables, which receive primary stress in Karaim and are significantly longer and more prominent generally than other

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[9] If this is an allophonic transcription, with the ụ denoting a perceptible but inconsistent difference in the vowels, then we may be overstating their case.

[10] Based on the recording, not on Csató and Nathan's transcription.

[11] The same argument holds for Southwest Karaim, which has only one /l/ phoneme, which surfaces as [-back] [l^{j}] before /i/, and as [+back] [ɬ] elsewhere. Crucially, the [+back] ɬ is not not affected by [back] harmony, and is transparent to it: /el-gAn/ 'die-ppl' → [eɬg^{j}en], not *[e$l^{j}g^{j}$en] (Kowalski 1929:44). Kowalski would have to have heard a [+back] [l] very clearly, in order to override the turcologist's expectation of [l^{j}] in this position. (Note moreover that the transparency of l here provides further evidence for Relativized Locality.)

syllables in the language, and hence are unlikely to pose greater discrimination challenges than initial syllables.

The fourth and most important reason to believe Kowalski's interpretation of the Northwest Karaim system is that it is phonetically justified, based on our spectrographic analysis of Csató and Nathan's recordings. Csató and Nathan employ three primary informants for their CD: one (Jozef Firkovich) matches most clearly with their transcriptions, complete with central vowels; another (the head of the community, Mykolas Firkovicius) has something closely resembling the Kowalski system; and the third also has a variant of the Kowalski system. In the remainder of this section we examine several recordings for each of the first two informants.

4.1 Mykolas Firkovicius

Mr. Firkovicius led the local Karaim community for fifty years, passing away recently in his 80s. Csató and Nathan 2002 contains recordings of six songs performed by him, excerpts of which we analyze here:

(20) samples of Mykolas Firkovicius' idiolect[12]

a. from the "Kïbïn Song"

Csató and Nathan's transcription	b'ɪz'-g'ạ üv'r'ạt'-t'i-l'ạr
how Kowalski would render	b'ɪz'-g'a üv'r'at'-t'i-l'ar
IPA[13]	[bʲɪzʲigʲa yvʲrʲatʰʲːilʲɑr]
gloss	we-DAT teach-PAST-PL
translation	'they taught us'

b. from the "Kïbïn Song"

Csató and Nathan's transcription	iš'-l'ạ-d'-l'ạr ana-lar
how Kowalski would render	iš'-l'a-d'-l'ar ana-lar
IPA[14]	[iʃʲlʲɑdʲlʲɑr ɑnaɬɑr]
gloss	work-DENOM-PAST-PL mother-PL
translation	'mothers made [them]'

c. from another song:

Csató and Nathan's transcription	k'ọt'-ụr'-m'ạ
how Kowalski would render	k'ot'-ur'-m'a
IPA[14]	[kʰʲotʰʲʉrʲʉmʲɑ]
gloss	rise-CAUS-INF
translation	'to raise'

d. from a psalm:

Csató and Nathan's transcription	k'ọt'ụr'-ụl'-g'ụn'
how Kowalski would render	k'ot'ur'-ul'-g'un'
IPA[14]	[kʰʲɔtʰʲʉrʲʉlʲʉgʲunʲ]
gloss	lift-MIDDLE-2SG.IMV
translation	'lift yourself up'

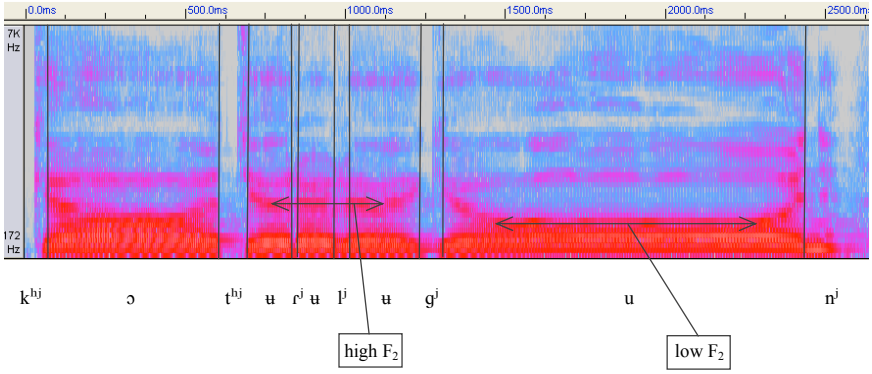
[12] Recordings of these excerpts can be heard, courtesy of Eva Csató and David Nathan, at www.uwm.edu/~vaux/karaim.

[13] Based on the recording, not on Csató and Nathan's transcription.

We have selected the phrases in (20) because they demonstrate a variety of long harmonic spans, containing some vowels that are centralized (20c-d) and some that are not (20a-b). Of particular interest is the recording of [iʃʲlʲɑdʲlʲɑr], which shows quite clearly that the [ɑ]'s are not fronted (or even centralized), even though they are flanked by consonants that have undergone [-back] harmony. The same point holds for the /o/'s in (20c-d).

Now consider the form in (20d), [kʰʲɔtʰʲʉɾʲʉlʲʉgʲunʲ], which contains a span of three centralized u's sandwiched by two full-fledged back vowels. The fact that the two outer vowels are back[14] whereas the three interior vowels are more front can be seen clearly in the spectrogram in (21), which shows that the latter have a noticeably higher F_2 value (the acoustic correlate of frontness/backness) than the initial [ɔ] and the final [u].

(21) spectrogram of Mykolas Firkovicius' [kʰʲɔtʰʲʉɾʲʉlʲʉgʲunʲ]



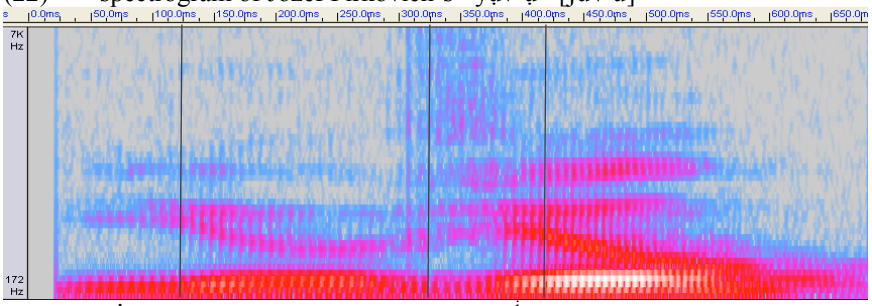
Why are the three middle vowels fronted whereas the two outer vowels aren't? We attribute this difference to the fact that the former are extremely short in duration (roughly 100 ms each, as opposed to 500 ms for the initial ɔ and 1100 ms for the stressed u), and thus more susceptible to coarticulation effects. The most important point about (21) for our purposes, though, is the fact that the initial [ɔ] and the final [u] are not fronted or centralized, despite occurring in a [-back] harmonic span. Conversely, it is equally important that the final [nʲ] is palatalized, despite being preceded by a clearly [+back] [u]; if [back] consonant harmony were unable to propagate through vowels, we would expect this /n/ to surface as [+back]. Instead, one can see clearly in the spectrogram that F_2 rises sharply at the beginning and end of the [u], as the tongue dorsum makes its transition from the [-back] position of the [gʲ] and [nʲ] to the [+back] position of the [u].

[14] The formant values for the final [u] are in fact comparable to those for a [u] in a [+back] span, indicating that the [u] is not centralized.

4.2. Jozef Firkovich

Phonetic analysis of the recordings of Jozef Firkovich yields similar results. Consider for example the manifestation of <yụv'ụ>[15] in the sentence anda ed'i yụv'ụ alarnïn, anda ed'i baxčasï də, b'ič'ạn'l'ig'i d'ə 'they had a house, a garden, and also a pasture', from a narrative about the Karaim street in Trakai. Here Csató and Nathan transcribe the two u's as centralized [ụ], as we should expect if [-back] is spreading to these from the adjacent consonants. Spectrographic analysis reveals, however, that the two u's are in fact back [u]'s, precisely as we would expect in Kowalski's scheme:

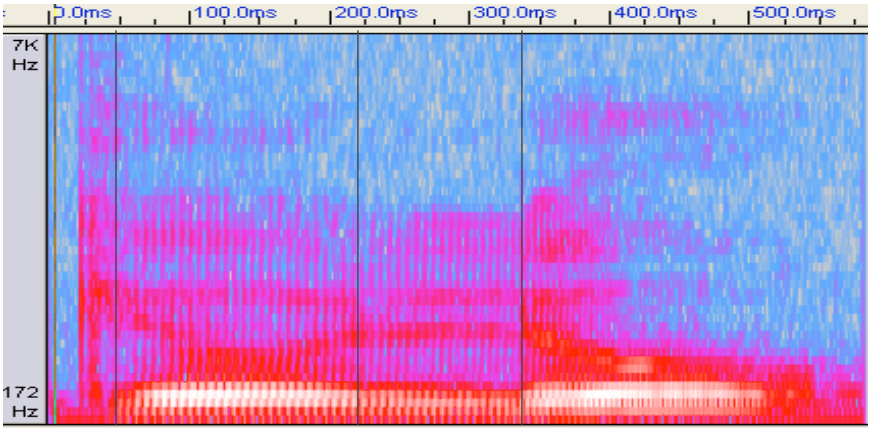
(22) spectrogram of Jozef Firkovich's <yụv'ụ> [juv^{j}u]



Notice that F_2 dips significantly during both vowels, as the tongue moves to its target [+back] position, as with the final [u] in (20). The same F_2 drop can be seen during the vowels in g'ọl'-ụ 'lake-ACC' in (23); here again the final [u] is clearly not affected by harmony, and the slight centralization of the /o/ can be attributed to phonetic coarticulation.

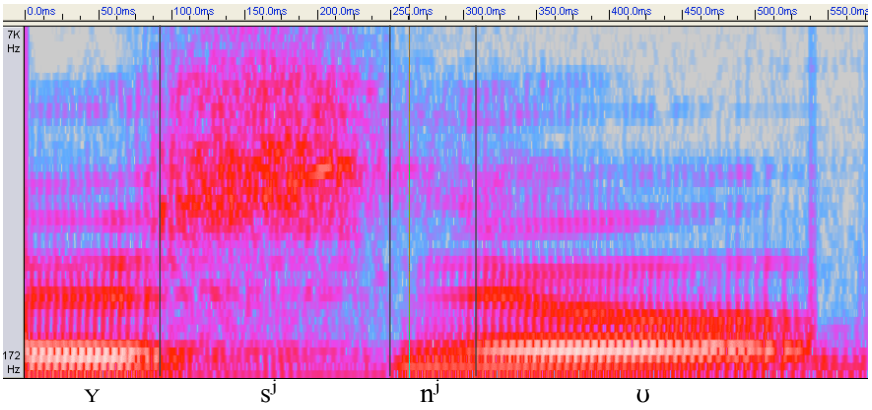
[15] Csató and Nathan's transcription; yụv'-ụ 'house-ACCUSATIVE' is cognate to Turkish ev-i.

(23) spectrogram of Jozef Firkovich's <g'o̧l'-u̧> [gʲɵlʲu](cf. Turkish *göl*)



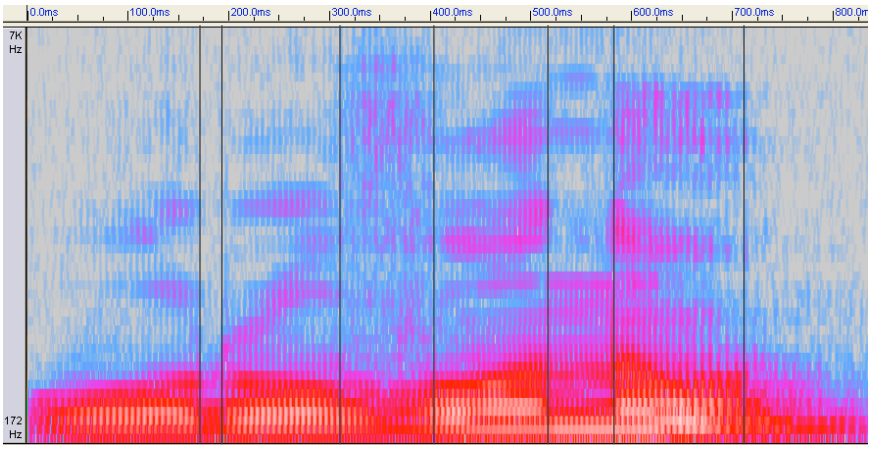
That [u] is distinct from [y] can be seen clearly in the spectrogram in (24), where F_1 is noticeably separated from F_2 in the initial [y], reflecting the high F_2 value we expect for a front vowel, whereas F_2 has lowered almost to the point of merging with F_1 in the final /u/, showing the low F_2 we expect for a back vowel.

(24) spectrogram of Jozef Firkovich's <üs'n'u̧> 'on' [ʏsʲnʲʊ]



Finally, in order to show that the [u]'s in the above [-back] harmonic spans are comparable to the [u]'s in [+back] harmonic spans, we present the form in (25).

(25) spectrogram of Jozef Firkovich's <uruv-u-nun> 'family-3SG-GEN'



One can see in (25) that the F_1 and F_2 values for the [u]'s are almost identical, precisely as with the word-final [u]'s in (22-24). Once can only conclude that each of these is an authentic [+back] [u], in agreement with Kowalski's description.

While on the topic of phonetic effects on non-participating segments, we note in passing that Gordon 1999 *does* have legitimate phonetic evidence for his assertion that Finnish /i/ is more back in [back] words, and (as we have just seen) Csató and Johanson are right in observing that vowels which are fronted in other Turkic languages are sometimes centralized in Northwest Karaim. As mentioned earlier, this centralization, which appears more prominently in super-short segments, is best explained as a coarticulatory effects from neighboring consonants, exactly as we find in other languages with consonantal backness contrasts such as Russian, Abkhaz, and Irish. This coarticulatory effect is considered to be a separate low-level phenomenon that occurs in the phonetic implementation in this latter set of languages, though, and we find it more reasonable to treat the Karaim facts with the same mechanism than to postulate a separate one designed just for Karaim and just so we can make the Karaim data more closely resemble what we find in other Altaic languages.

To summarize the results of this section, it is clear that Kowalski was correct in stating that Northwest Karaim has consonant harmony that does not affect (most) intervening vowels. We have seen that he needed good reason to depart from the transcriptions that a turcologist would expect, he displayed the ability to discriminate the relevant phonetic contrasts for backness, and his findings are supported by phonetic analysis of native Karaim speakers.

5. Conclusions

Consonant harmony in Northwest Karaim provides a case of consonant harmony for the feature [-back], disproving typological claims that such phenomena do not exist. The existence of non-local identity in feature specifications shows that harmony cannot be reduced to pure articulatory optimization, but rather must involve operations on features at a more abstract level of representation.

References

Ao, B. (1991). Kikongo nasal harmony and context-sensitive underspecification. *Linguistic Inquiry* 22:193-196.

Clements, G. Nick and Elizabeth Hume (1995). The internal organization of speech sounds. In *The handbook of phonological theory*, John Goldsmith, ed., 245-306. Oxford: Blackwell.

Comrie, Bernard (1981). *The languages of the Soviet Union*. Cambridge: Cambridge University Press.

Csató, Eva (1997). Turkic and Slavic language contacts: the case of Karaim in Lithuania and the Ukraine. Manuscript, Uppsala University.

Csató, Eva (1999). Syllabic harmony in Turkic: The evidence of code-copying. In Bernt Brendemoen et alii (eds) *Language encounters across time and space*, pp. 341-352. Oslo: Novus Press.

Csató, Eva and Lars Johanson (1995). Zur Silbenharmonie des Nordwest-Karaimischen. *Acta Orientalia Hungarica* 48:329-337.

Csató, Eva and David Nathan (2002). *Spoken Karaim*. CD-ROM, Uppsala University.

Flemming, Edward (1996). Transparency and locality in assimilation. Abstract of colloquium paper delivered at Stanford University. (http://www-linguistics.stanford.edu/Linguistics/ colloq/19960119.html)

Gafos, Adamantios (1998). Eliminating Long Distance Consonantal Spreading. *Natural Language and Linguistic Theory* 16.2:223-278.

Gafos, Adamantios (1999). *The Articulatory Basis of Locality in Phonology*. Garland Publishers, New York.

Gordon, Matthew (1999). The neutral vowels of Finnish: How neutral are they? *Linguistica Uralica* 35:17-21.

Hamp, Eric (1976). Palatalization and harmony in Gagauz and Karaite. In W. Heissig et al., eds., *Tractata Altaica*, pp. 211-213. Wiesbaden: Harrassowitz.

Hansson, Gunnar (2001). *Theoretical and Typological Issues in Consonant Harmony*. Doctoral dissertation, University of California, Berkeley.

Kaye, Jonathan, Jean Lowenstamm, and Jean-Roger Vergnaud (1985). The internal structure of phonological elements: a theory of charm and government. *Phonology Yearbook* 2:305-328.

Kowalski, Tadeusz (1929). *Karaimische texte im dialekt von Troki*. Prace Komisji Orjentalistycznej Polskiej Akademji Umiejętności nr. 11. Cracow: Nakładem Polskiej Akademji Umiejętności.

McCarthy, John (1998). Morpheme Structure Constraints and Paradigm Occultation. In *CLS 32, vol. II: The Panels*, M. Catherine Gruber, Derrick Higgins, Kenneth Olson, and Tamra Wysocki, eds., pp. 123-150. Chicago: Chicago Linguistic Society.

McCarthy, John and Alan Prince (1993). *Prosodic Morphology: Constraint Interaction and Satisfaction*. RuCCS-TR-3. ROA-482.

Nevins, Andrew (to appear). Universal Quantification and Generalized Structural Descriptions. In *Rules and representations in contemporary phonological theory*, Bert Vaux, ed. Oxford: Oxford University Press

Odden, David (1994). Adjacency parameters in phonology. *Language* 70.2:289-330.

Ohala, John (1981). The listener as a source of sound change. In *Papers from the parasession on language and behavior*, C. Masek, R. Hendrik, and M. Miller, eds., pp. 178-203. Chicago: Chicago Linguistic Society.

Reiss, Charles (2003). Towards a theory of fundamental phonological relations. In Anna Maria DiSciullo, ed., *Asymmetry in Grammar. Volume 2: Morphology, phonology, acquisition*. Amsterdam: John Benjamins.

Rialland, Annie and Redouanne Djamouri (1984). Harmonie vocalique, consonantique et structures de dépendance dans le mot en mongol khalkha. *Bulletin de la Société de Linguistique de Paris* 79.1:333-383.

Rizzi, Luigi (1990). *Relativized minimality*. Cambridge: MIT Press.

Shademan, Shabnam (2003). Epenthetic vowel harmony in Farsi. Paper presented at WCCFL, San Diego.

Svantesson, Jan-Olof (1985). Vowel harmony shift in Mongolian. *Lingua* 67.4:283-329.

Vaux, Bert (1999). Does consonant harmony exist? Paper presented at the LSA Annual Meeting, available at www.uwm.edu/~vaux/lsa1999.pdf.

Walker, Rachel (1999). Guaraní voiceless stops in oral versus nasal contexts: an acoustical study. *Journal of the International Phonetic Association* 29.1:63-94.

Appendix 1

IPA	Kowalski	Csató/Nathan	comments
l	l	l’	light l
ɫ	ɫ	l	dark l
ɾ	r	r	tapped rhotic
ɾ^{j}	r’	r’	palatalized rhotic
r	r	r	trilled rhotic used in some of Csató and Nathan’s recordings
d	d	d	
d^{j}	d’	d’	
t^{h}	t	t	voiceless stops are normally aspirated
t^{hj}	t’	t’	palatalized t
n	n	n	
n^{j}	n’	n’	
z	z	z	
z^{j}	z’	z’	
s	s	s	
s^{j}	s’	s’	
ʃ	š	š	

ʃʲ	š’	š’	
tʃ	č	č	
tʃʲ	č’	č’	
p^h	p	p	
(p^{hj})	(p’)	(p’)	coda p is normally not palatalized
b	b	b	
b^j	b’	b’	
m	m	m	
m^j	m’	m’	
k^h	k	k	
k^{hj}	k’	k’	
g	g	g	
g^j	g’	g’	
j	j	y	palatal glide
w	w	w	
i	i	i	
e	e	e	
ɑ, a	a	a	
o, ɔ	o	o	
u, ʊ	u	u	
ɯ	y	ï	high back unrounded vowel
y	ü	ü	high front rounded vowel
ø	ö	ö	mid front rounded vowel

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