Disharmony and derived transparency in Uyghur Vowel Harmony[*]

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1. Introduction

Uyghur is generally believed to possess a vowel harmony system very similar to the one found in its relative Turkish, save for the fact that in Uyghur *i* is neutral and transparent (Lindblad 1990, Hahn 1991, Alling 1999). In this paper I argue on the basis of the phonological behavior of disharmonic vowels that Uyghur vowel harmony is actually quite different from the Turkish system in that harmony propagates only [-back] and harmony applies both cyclically and post-cyclically. I demonstrate furthermore that the Uyghur facts can only be insightfully accounted for in a theory that assumes derivations, cyclicity, and visibility of the sort elaborated in Halle and Vergnaud 1987, Halle 1995, Calabrese 1995, Vaux 1998, and Halle, Vaux, and Wolfe 2000. Theories of harmony that model transparency and opacity in terms of featural underspecification and prespecification respectively (e.g. Clements 1976, Clements and Sezer 1982, Clements 1987) fail to account for derived transparency in Uyghur, and output-driven OT frameworks such as Cole and Kisseberth 1994, Pulleyblank 1996, and Ringen and Heinämäki 1999 are unable to capture the range of surface facts produced by the interaction of cyclic and post-cyclic vowel harmony with post-cyclic vowel raising in cyclic and non-cyclic environments.

2. Outline of Uyghur phonology and harmony

Uyghur has the inventory of vowel allophones in (1) (Lindblad 1990, Hahn 1991).[1]

(1) Uyghur surface vowels

	[-back]		[+back]	
	[-round]	[+round]	[-round]	[+round]
[+high]	i	ü		u
[-high, -low]	e	ö		o
[+low]	ä		a	

Note that the feature [back] is not contrastive for [i] and [e], but is contrastive for the rest of the vowels; this fact will play an important role in the analysis developed in this paper.

As a general rule all vowels in a word must share the same specification for the feature [back], as in Turkish. (Notable exceptions include compounds, loans, and neutral and

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[1] The scheme in (1) abstracts away from variations induced by neighboring consonants and syllabic position, which are not relevant here. The interested reader should consult Hahn 1991a for further details.

disharmonic vowels.) Consequently, suffixal vowels surface with the rightmost [back] value in the root to which they attach, as illustrated in (2) for the plural -*lAr*-, the dative -*GA*-, and the first person singular possessive -*Vm*-. (Capital letters denote harmonic segments. Uyghur also possesses rounding harmony, which I do not consider in this paper.)

(2) representative cases of vowel harmony (Lindblad 1990:17)

sg.	**pl. -lAr-**	**dat. -GA-**	**1sg poss. -Vm-**	**gloss**
yol	*yollar*	*yolʁa*	*yolum*	road
pul	*pullar*	*pulʁa*	*pulum*	money
at	*atlar*	*atqa*	*etim*	horse
köl	*köllär*	*kölgä*	*kölüm*	lake
yüz	*yüzlär*	*yüzgä*	*yüzüm*	face
xät	*xätlär*	*xätkä*	*xetim*	letter

The two vowels in (1) that are not contrastive for the feature [back], *i* and *e*, are neutral and transparent with respect to [back] harmony in Uyghur. (Note, though, that *e* occurs only in loanwords and as the result of an Umlaut rule that raises low vowels in initial syllables before *i*; its phonological status is not entirely clear, and will not be discussed in this paper.) The neutrality of *i* can be seen in the behavior of the first person plural possessive suffix -*imiz*-, whose vowels remain [-back][2] regardless of the [back] specification of the root to which the suffix attaches (3a). The transparency of *i* can be seen in the possessive dative forms (3b), where in *kölimizgä* for example the [-back] specification of the root *köl* spreads to the suffix -*GA*- through the two intervening *i*'s of -*imiz*-.

(3)

sg.	**a. 1pl poss. -ImIz-**	**b. -ImIz-GA-**	**gloss**
yol	*yolimiz*	*yolimizʁa*	road
pul	*pulimiz*	*pulimizʁa*	money
köl	*kölimiz*	*kölimizgä*	lake
yüz	*yüzimiz*	*yüzimizgä*	face

As shown in (4), roots containing only neutral vowels generally select [+back] suffixes, regardless of whether the neutral vowels in question derive historically from front or from back vowels (Lindblad 1990:23, 30, 32).

(4)

native	*deŋiz-ʁa*	sea-dat.	Proto-Turkic **täŋiz*
	til-lar	tongue-pl.	Proto-Turkic **til*
Arabic	*sinip-ta*	class-loc.	
Russian	*enžinir-lar*	engineer-dat.	

[2] Neutral vowels do not covertly (i.e. phonetically) alternate, pace some versions of Strict Locality; cf. Lindblad 1990:13 "+*nIŋ*+ is always pronounced with [phonetic] schwa as its vowel, regardless of its [underlying] backness value as revealed by harmonic processes."

Following Lindblad (1990:36), I assume in order to account for the facts in (4) that Uyghur possesses a default rule that assigns [+back] to harmonic vowels that do not receive a value for the harmonic feature during the course of the derivation (cf. (5vi) below). The few neutral roots that exceptionally select [-back] suffixes are postulated to have a floating [-back] specification in their lexical representations that then spreads to subsequent harmonic segments in the word.

The basic scheme of Uyghur vowel harmony outlined above appears relatively straightforward, being similar to better-known harmonic systems of the sort found in Finnish. Lindblad 1990 analyzes the Uyghur system as follows:

(5) Lindblad's analysis of Uyghur [back] harmony

i. Non-alternating vowels (except for neutral vowels) are underlyingly specified for the feature [back].

ii. Harmonic vowels and neutral vowels are underlyingly unspecified for [back].

iii. A cyclic rule of Vowel Harmony spreads the [back] specification(s) of the root outward to affixes within the same word. (Both [+back] and [-back] are able to spread.)

iv. Vowel Harmony is feature-filling, and therefore does not apply to segments that are already specified for the harmonic feature.

v. Neutral vowels are underlyingly unspecified for [back] and therefore can undergo Vowel Harmony. Once they receive a [back] specification, they are free to spread this harmonic feature to following segments. Neutral vowels that receive a [+back] specification via Vowel Harmony subsequently become [-back] by the application of a neutralizing postlexical Fronting rule.

vi. Vowels that have not received a [back] specification during the course of the derivation are assigned the value [+back].

Further reflection on the Uyghur facts reveals three serious problems with Lindblad's analysis. First of all, as Kenstowicz (1994:357) has pointed out, it is undesirable to postulate an abstract intermediate derivational stage at which neutral vowels take on and propagate harmonic feature values, only to be neutralized at a later stage of the derivation. Uyghur has no back [ɨ] in its underlying representations, nor are there any at the phonetic surface[3], yet Lindblad's analysis of Uyghur posits their existence at an intermediate level. However, there is no independent evidence that would corroborate this hypothetical intermediate stage for neutral vowels. We can't use the [+back] specification on the following vowels as support, because this is exactly what the hypothetical intermediate stage is posited to explain.

In order to avoid unmotivated abstraction, I assume that neutral vowels are fully specified at all derivational levels of the derivation. This requires that we provide an alternative explanation for the transparent behavior of neutral vowels; I return to this issue in section 4.

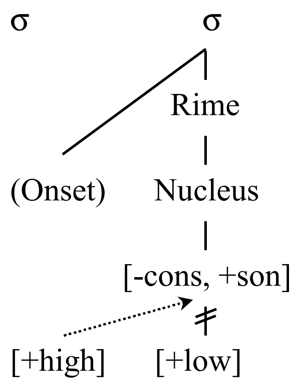
[3] Again ignoring variations induced by neighboring consonants; cf. footnote 1.

The second problem with Lindblad's analysis involves disharmonic roots, which reveal an asymmetry in harmonic behavior between [+back] and [-back]. The third problem involves the unexpected transparency of derived neutral vowels. Both of these problems are elucidated by a rule of Raising, to which I now turn.

3. Raising and asymmetric spreading

Lindblad (1990:10) and Hahn (1991b:84) describe a rule of Uyghur phonology that changes low vowels to high vowels in medial open syllables.

(6) Raising: /*a*, *ä*/ → [*i*] in medial open syllables



Some of the effects of Raising can be seen in (7).

(7)	**underlying form**	**surface form**	**gloss**
a. /*a*/	*bala*	*bala*	child
	bala-lAr	*bali̱lar*	children
	bala-lAr-i	*bali̱li̱ri*	his/her/its children
b. /*ä*/	*išäG*	*išäk*	donkey
	išäG-lAr	*išäxlär*	donkeys
	išäG-i	*iši̱γi*	his/her/its donkey
	išäG-i-GA	*iši̱γiγä*	to his/her/its donkey

This Raising rule is interesting because it changes a harmonic vowel into a neutral vowel. Given that underived *i* is transparent in Uyghur, we might expect derived *i* to be transparent as well. This expectation can be tested with disharmonic roots such as *äswap* 'tool', which contains both a [-back] harmonic vowel, *ä*, and a [+back] harmonic vowel, *a*. Harmonic suffixes added to such roots share the [back] specification of the closest root vowel: /*äswab-GA*/ 'tool-dative' → [*äswapqa*], etc. When Raising neutralizes the final disharmonic root vowel to [*i*], we expect if the new neutral vowel is transparent that the [back] specification of the preceding vowel should spread through it to any suffixes that follow, provided that Vowel Harmony is ordered after Raising. The two basic ordering relationships are illustrated in (8).

(8) Predicted behavior of disharmonic roots if derived neutral vowels are transparent

i. Raising precedes Vowel Harmony

	/äswab-i-GA/	*/adäm-i-GA/*	*/qähwa-GA/*	*/aʁinä-GA/*
	'tool-3sg poss.-dat.'	'man-3sg. poss.-dat.'	'coffee-dat.'	'friend-dat.'
Raising	*äswibiGA*	*adimiGA*	*qähwiGA*	*aʁiniGA*
VH	*äswibigä*	*adimiʁa*	*qähwigä*	*aʁiniʁa*
surface form	[*äswibiγä*]	[*adimiʁa*]	[*qähwiγä*]	[*aʁiniʁa*]

ii. Vowel Harmony precedes Raising

	/äswab-i-GA/	*/adäm-i-GA/*	*/qähwa-GA/*	*/aʁinä-GA/*
VH	*äswabiʁa*	*adämigä*	*qähwaʁa*	*aʁinägä*
Raising	*äswibiʁa*	*adimigä*	*qähwiʁa*	*aʁinigä*
surface form	[*äswibiʁa*]	[*adimiγä*]	[*qähwiʁa*]	[*aʁiniγä*]

Conversely, if the derived *i* is opaque we should expect it to block propagation of [back] from a preceding vowel to a following vowel. Suffixes in this situation would surface either as [+back] (if Raising bleeds Vowel Harmony, the harmonic suffixal vowels would receive [+back] by default, by (5vi)), or with the original [back] specification of the raised vowel, if Vowel Harmony precedes Raising. These alternatives are sketched in (9).

(9) Predicted behavior of disharmonic roots if derived neutral vowels are opaque

i. Raising precedes Vowel Harmony

	/äswab-i-GA/	*/adäm-i-GA/*	*/qähwa-GA/*	*/aʁinä-GA/*
Raising	*äswibiGA*	*adimiGA*	*qähwiGA*	*aʁiniGA*
VH	—	—	—	—
default [+bk]	*äswibiʁa*	*adimiʁa*	*qähwiʁa*	*aʁiniʁa*
surface form	[*äswibiʁa*]	[*adimiʁa*]	[*qähwiʁa*]	[*aʁiniʁa*]

ii. Vowel Harmony precedes Raising

	/äswab-i-GA/	*/adäm-i-GA/*	*/qähwa-GA/*	*/aʁinä-GA/*
VH	*äswabiʁa*	*adämigä*	*qähwaʁa*	*aʁinägä*
Raising	*äswibiʁa*	*adimigä*	*qähwiʁa*	*aʁinigä*
default [+bk]	—	—	—	—
surface form	[*äswibiʁa*]	[*adimiγä*]	[*qähwiʁa*]	[*aʁiniγä*]

The predicted outcomes in (8) and (9) hold if both Vowel Harmony and Raising are non-cyclic. If one or both rules are cyclic, the predictions in (10) apply.

(10)	**situation**	**prediction**
i.	Raising is cyclic, VH is non-cyclic; i is transparent	same as (8i)
ii.	Raising is cyclic, VH is non-cyclic; i is opaque	same as (9i)
iii.	Raising is non-cyclic, VH is cyclic; i is transparent	same as (8ii)
iv.	Raising is non-cyclic, VH is cyclic; i is opaque	*äswibiʁa, adimiʁa, qähwiʁa, aʁiniγä*
v.	both are cyclic; Raising >> VH; i is transparent	same as (8i)
vi.	both are cyclic; Raising >> VH; i is opaque	same as (9i)
vii.	both are cyclic; VH >> Raising; i is transparent	*äswibiγä, adimiʁa, qähwiʁa, aʁiniγä*
viii.	both are cyclic; VH >> Raising; i is opaque	same as (10iv)

Interestingly, none of the predictions in (8-10) are borne out. As the data in (11) demonstrate, the correct generalization is that if the last vowel in a disharmonic root raises, harmonic suffixes surface as [-back] provided that either a) the raised vowel is underlyingly [-back] or b) the first non-neutral vowel to the left of the raised vowel is [-back].

(11) Effects of Raising with disharmonic roots

	root	**suffixed form**	**gloss**
a. ä-a	*äswap*	*äswibiγä*	to his tool
	qähwa	*qähwiγä*	to the coffee
	ämma	*ämmilär*	buts (but-plural)
	Änǰan	*Änǰiniγä*	to his Anjan (personal name)
b. a-ä	*adäm*	*adimiγä*	to his man
	apät	*apitiγä*	to his disaster
	rošän	*rošiniγä*	to his Roshän (personal name)
	aʁinä	*aʁinilär*	his friends

How do we account for the fact that the actual forms in (11) do not conform to any of the predictions in (8-10)? Given the fact that [-back] appears to "win out" over [+back] in (11), it seems reasonable to adopt the popular assumption that only one value for the harmonic feature—in this case [-back]—is actually active in the harmonic system (cf. Kenstowicz 1983, Farkas and Beddor 1987, Archangeli and Pulleyblank 1989, 1993, and many others). If this is the case, then in order to account for forms such as /*bala-lAr*/ 'children' → [*balilar*] (7) we must of course assume either that harmonic vowels are underlyingly specified as [+back], or that a redundancy rule assigns [+back] to unspecified vowels at a late stage in the derivation. The former option requires postulating that Vowel harmony is feature-changing, which would wreak havoc in various corners of our treatment of vowel harmony. We therefore opt for the latter strategy, a [+back] redundancy rule, which we in fact already adopted earlier to account for the harmonic behavior of roots containing only neutral vowels (cf. (5v)).

These assumptions will account for the forms in (11b), provided we assume that Vowel Harmony applies before Raising. How then do we explain the forms in (11a)? If Vowel Harmony precedes Raising, a form like /*äswab-i-GA*/ (12) should have the derivation in (13):

(12) underlying form *ä s w a b - i - G A*

[-bk]	[+bk]	[-bk]

Comments:

- Disharmonic vowels are underlyingly specified for the harmonic feature (5i).
- Neutral vowels are underlyingly specified for the harmonic feature.
- Harmonic vowels are underlyingly unspecified for the harmonic feature (5ii).

(13)

rule	output	comments
Vowel Harmony	*äswabiGA*	[-back] value of root *ä* is blocked from spreading to suffix by intervening disharmonic *a*, which has lexical [+back] specification. [+back] value of root *a* does not spread to suffixes, because the rule of Vowel Harmony spreads only [-back].
Raising	*äswi̲biGA*	
default [+back]	*äswibiʁa̲*	
surface form	*[*äswibiʁa*]	

In order to account for forms like *äswibiγä*, we have to assume that Vowel Harmony also applies *after* Raising, so that the [-back] specification of the root *ä* can spread to the harmonic suffix. It is not unusual to find a phonological rule ordered both before and after another rule; such cases are well-known in the phonological literature (cf. Matushansky 2000). This effect will emerge in either of the following two situations:

(14) i. Both Vowel Harmony and Raising are cyclic.
ii. Vowel Harmony is both cyclic and non-cyclic, and Raising is non-cyclic. In the non-cyclic block, Raising precedes Vowel Harmony.

We can rule out (14i) for Uyghur, because it cannot account for the treatment of raising disharmonic roots of the type in (11b) when followed by a neutral-vowel suffix followed by a harmonic suffix, such as /*adäm-i-GA*/. If both Vowel Harmony and Raising were cyclic we would incorrectly predict *[*adimiʁa*], as outlined in (15) and (16).

(15) derivation of /*adäm-i-GA*/ if derived *i* is transparent

i.	underlying form	[[[*adäm*]-*i*]-*GA*]		
ii.	cycle 1	[*adäm*]	VH	—
			Raising	—
iii.	cycle 2	[[*adäm*]-*i*]	VH	—
			Raising	*adim-i*
iv.	cycle 3	[[[*adim*]-*i*]-*GA*]	VH	*adimiʁa*
			Raising	—
v.	surface form			*[*adimiʁa*]

(16) derivation of /*adäm-i-GA*/ if derived *i* is opaque

i.	underlying form	[[[*adäm*]-*i*]-*GA*]		
ii.	cycle 1	[*adäm*]	VH	—
			Raising	—
iii.	cycle 2	[[*adäm*]-*i*]	VH	—
			Raising	*adim-i*
iv.	cycle 3	[[[*adim*]-*i*]-*GA*]	VH	—
			Raising	—
v.	post-cyclic block	*adimiGA*	default [+bk]	*adimiʁa*
vi.	surface form			*[*adimiʁa*]

Since theory (14i) does not derive the correct outputs we must assume option (14ii), namely that Vowel Harmony is both cyclic and non-cyclic, and Raising is non-cyclic and precedes Vowel Harmony in the non-cyclic block.

Thus far the data have led us to develop a theory of vowel harmony with the following components:

(17) Uyghur Vowel Harmony (pre-final formulation)

i. Non-alternating vowels are underlyingly specified for [back].

ii. Harmonic vowels are underlyingly unspecified for [back].

iii. Vowel Harmony spreads [-back] specification(s) of the root outward to affixes within the same word. It applies in both the cyclic and post-cyclic rule blocks.

iv. Though [+back] specifications do not spread, they do block propagation of [-back] specifications through them. (In other words, [+back] is not underspecified.)

v. Vowel Harmony is feature-filling, and therefore does not apply to segments that are already specified for the harmonic feature.

vi. Raising is non-cyclic; within the post-cyclic stratum it precedes Vowel Harmony.

vii. Vowels that have not received a [back] specification during the course of the derivation are assigned the value [+back] by a redundancy rule.

4. Transparency

One aspect of the data presented thus far remains to be accounted for: the behavior of derived neutral vowels. Given the assumptions to which we have been led so far, it turns out that derived neutral vowels must be transparent. This can be seen by examining the derivation of a word like /*äswab-i-GA*/ 'to his tool'. According to the scheme established in the preceding section, this underlying form can have two possible outcomes, depending on whether derived neutral vowels are transparent (18) or opaque (19).

(18) derivation of /*äswab-i-GA*/ if derived *i* is transparent

i.	underlying form	[[[*äswab*]-*i*]-*GA*]		
ii.	cycle 1	[*äswab*]	VH	—
iii.	cycle 2	[[*äswab*]-*i*]	VH	—
iv.	cycle 3	[[[*äswab*]-*i*]-*GA*]	VH	—
v.	post-cyclic	*äswabiGA*	Raising	*äswibiGA*
			VH	*äswibigä*
vi.	surface form			[*äswibiγä*]

(19) derivation of /*äswab-i-GA*/ if derived *i* is opaque

i.	underlying form	[[[*äswab*]-*i*]-*GA*]		
ii.	cycle 1	[*äswab*]	VH	—
iii.	cycle 2	[[*äswab*]-*i*]	VH	—
iv.	cycle 3	[[[*äswab*]-*i*]-*GA*]	VH	—
v.	post-cyclic	*äswabiGA*	Raising	*äswibiGA*
			VH	—
			default [+bk]	*äswibiʁa*
vi.	surface form			*[*äswibiʁa*]

The derivation in (19) demonstrates that if derived *i* is opaque, we incorrectly predict the surface form of 'to his tool' to be *[*äswibiʁa*]. If derived neutral vowels are transparent, on the other hand, the correct surface form results. (The same holds for the remainder of the data discussed thus far.)

That <u>derived</u> *i* is transparent might initially appear to make sense, since we already know that <u>underived</u> *i* is transparent (cf. *yolimizʁa* vs. *kölimizgä* in (3)). However, it turns out that this transparency is not always predicted for such cases by the most popular analysis of disharmonic vowels (Clements and Sezer 1982, etc.), which employs prespecification in the manner described in (17i).

In order to see how this works consider first the disharmonic Uyghur gerund -GU, whose vowel agrees in backness with the last preceding harmonic vowel, but invariably surfaces as [+high] and [+round] (Lindblad 1990:17).

(20)	**root**	**gerund**	**gloss**
a. [+back]	*bol*	*bolʁu*	become
	oqut	*oqutqu*	teach
	yaz	*yazʁu*	write
b. [-back]	*kör*	*körgü*	see
	küt	*kütkü*	wait
	käl	*kälgü*	come

As we have already seen, traditional treatments of vowel harmony maintain that vowels showing harmonic alternations are underlyingly unspecified for the harmonic feature, disharmonic vowels are underlyingly prespecified for the harmonic feature, and vowel harmony is feature-filling (Lightner 1967, Zimmer 1967, Clements 1976, Crothers and Shibatani 1980, Binnick 1980, Steriade 1981, 1987, Clements and Sezer 1982, etc.). According to these assumptions, the vowel of the gerund suffix should be prespecified as [+high, +round], since it invariably surfaces with these feature values.

By the same reasoning, both of the vowels in a disharmonic root like *adäm* should be prespecified for [back], since neither vowel alternates for this feature. The lexical representation for *adäm* will therefore include the following structure:

(21) *a* *d* *ä* *m*
| |
[+back] [-back]

Now consider what happens to the second disharmonic vowel if we place it in an open syllable by adding appropriate suffixes, as in /*adäm-i-CA*/ (-*CA* is a hypothetical non-cyclic suffix consisting of a consonant followed by a harmonic low vowel. I have chosen a non-cyclic suffix in order to prevent Vowel Harmony from applying to it during the cycle, which would block the effects of our demonstration.) What effect does Raising have on this representation? Given the formulation in (6), Raising should simply make the *ä* [+high]; crucially, the lexical [+back] specification remains unchanged. Raising therefore produces the representation in (22):

(22) [+high]
|
a *d* *i* *m* - *i* - *C* *A*
| |
[+back] [-back]

Since the derived *i* in (22) is specified as [-back], the prespecification analysis predicts that it should be opaque, blocking rightward propagation of [back] from vowels to its left. (Recall that the prespecification analysis derives transparency via underspecification, as in (5ii); in order for the *i* to be transparent to back harmony, it must be unspecified for [back].) As it happens, the predicted opacity in (22) has no observable effects, since the suffixal low vowel will end up being assigned a default [+back] specification (cf. (5vi), (17vii)), which is the same value it would receive from the first root vowel if the derived *i* were transparent.

The behavior of forms like /*äswab-i-GA*/ can also be accounted for in the prespecification theory, with one adjustment. Raising in this case should produce *äswɨbiGA*, with the disharmonic *a* becoming a high back vowel *ɨ*. A back vowel of this type would block Vowel Harmony, but we know that a rule of Neutralization changes this vowel to [-back] by the end of the derivation. Ordering Neutralization before non-cyclic Vowel Harmony can produce the desired transparency effect. However, this is only possible if we stipulate that Neutralization first deletes the [+back] specification of the *ɨ*, and then Vowel Harmony applies, followed finally by the rule that fills in the surface [-back] specification of the [i]. This analysis runs into the same problems of abstraction encountered by Lindblad's theory of covertly alternating neutral vowels, and therefore should be avoided if possible.

The prespecification analysis furthermore encounters a similar problem in the behavior of non-cyclic disharmonic suffixes. Consider the modal suffix -*čä*-, which invariably surfaces with a [-back] vowel, regardless of the [back] specification of the root to which it attaches:

(23)		**surface form**	**gloss**
a.	[-back] roots	*türk-čä*	(in the) Turkish (manner/language)
b.	[+back] roots	*uyʁur-čä*	(in the) Uyghur (manner/language)
		taχ-čä	(one) as big as a mountain
		kitap-čä	booklet
		on-čä	about ten

Since the vowel in /-*čä*/ does not alternate for backness, it should be underlyingly specified as [-back] according to the treatment of disharmonic vowels described earlier.

(24)
$$\begin{array}{ll} \check{c} & \ddot{a} \\ & | \\ & [\text{-back}] \end{array}$$

The disharmonic *ä* of the -*čä* suffix furthermore spreads its own [back] specification to following vowels, e.g. /*kita:b-čä-m-DA*/ 'in my booklet' → [*kitapčämdä*].

The key fact for the purposes of our discussion is that -*čä* can undergo Raising: cf. /*näy-čä-DA*/ 'small flute-loc.' → [*näyčidä*]. Interestingly, the expected outcomes do not appear when Raising targets -*čä*- attached to a [+back] root and followed by one or more harmonic suffixes. In this case, illustrated by /*kita:b-čä-DA*/ 'booklet-locative', we expect the derivation in (25) to apply.

(25)	underlying form	[[[*kita:b*]-*čä*]-*DA*]
	cycle 1 VH	—
	cycle 2 VH	—
	cycle 3 VH	*kita:b-čä-dä*
	Raising	*kita:bčidä*
	VH	—
	surface form	*[*kitapčidä*][4]

The correct surface form is [*kitapčida*]. The generalization here is that harmonic suffixes after raised -*čä*- always agree in backness with the last harmonic vowel preceding -*čä*-, as shown in (26) (data from Lindblad 1990:45).

(26)	**underlying form**	**surface form**	**gloss**
a. [-back] root	*näy-čä-DA*	*näyčidä*	child
b. [+back] root	*kita:b-čä-DA*	*kitapčida*	in the booklet
	oʁl-čä-lA-b	*oʁulčilap*	done a boy's way
	ziχ-čä-GA	*ziχčiʁa*	to/for the skewer

Why does the raised form of -*čä* behave in this way? Recent treatments of Uyghur Vowel Harmony assume that -*čä* becomes transparent in this situation (Shinjang Komiteti 1985:25-27, Lindblad 1990:45, Hahn 1991). That -*čä* becomes transparent here is descriptively clear, and conforms to our earlier conclusion that derived neutral vowels are transparent. What is not so clear is (i) *why* neutral vowels derived from disharmonic vowels become transparent, when the theories espoused by Lindblad and Clements and Sezer predict that they should not, and (ii) why VH does not spread the [-back] value of -*čä*- before Raising applies.

Lindblad (1990:47) suggests that the morpheme -*čä*- merges with the unrelated agentive morpheme -*či*- in raising contexts; since -*či* is transparent, he reasons, raised -*čä* can also behave transparently if it is confused with underlying -*či* by speakers. This hypothesis is not coherent in formal phonological terms, however, and also fails to account for the fact that all neutral vowels derived from disharmonic vowels behave in the same manner, even when they do not have similar-sounding transparent suffixes to be conflated with. We have already seen how this works for a root-internal derived neutral vowel in [*äswibigä*]; the same pattern is apparent with the suffix -*anä*-, which shows the same behavior as -*čä* in words like /*äxmäq-anä-liG*/ 'stupidity' → [*äxmiqaniliq*].

Since Lindblad's account for the transparency of raised -*čä* is not viable, let us consider how the analysis I have developed thus far deals with the same facts. First of all, it is clear that -*čä*-, -*anä*-, and the other suffixes that behave in this way must be non-cyclic; if they were cyclic, application of cyclic VH would invariably spread the harmonic feature specification of these

[4] We ignore here two rules of vowel shortening and consonant devoicing that are not relevant for our purposes.

suffixes to the following vowel, producing incorrect forms such as *[*kitapčidä*]. If -*čä*- is non-cyclic, on the other hand, it will not trigger cyclic VH, and any following harmonic segments will therefore enter the post-cyclic rule block still unspecified for [back]. By assuming that the relevant suffixes are non-cyclic, therefore, we account for the previously mysterious fact that VH does not propagate the [-back] feature of these suffixes before they undergo Raising.

It is not sufficient to assume that these suffixes are non-cyclic, though. The problem is that when -*čä*- undergoes Raising in the post-cyclic block it should remain disharmonic, since its underlying [-back] specification is not affected (cf. (22)). If the derived *i* in *näyčiDA* blocks harmony for this reason and moreover is unable to spread its own [-back] specification to the following harmonic vowel, we then expect the harmonic vowel to receive a default [+back] specification, yielding the incorrect surface form *[*näyčida*]. If on the other hand the derived *i* is able to spread its own [-back] specification, we predict that this will spread to the harmonic suffixal vowel in /*kita:b-čä-DA*/, producing the incorrect surface form *[*kitapčidä*] rather than the attested [*kitapčida*].

Clearly our assumptions about whether or not derived neutral vowels are able to spread are not going to solve the problem of why disharmonic vowels become transparent under Raising. Let us therefore adopt the simplest position, according to which derived neutral vowels are no different than underlying neutral vowels; in other words, they do not spread their own specification for [back]. This being the case, we have to explain how the final vowel in *näyčidä* receives its [-back] specification.

The only logical explanation is (as we already concluded on the basis of *äswibigä*) that derived neutral vowels *are* transparent, contrary to prespecification-based accounts of disharmony, which crucially require derived neutral vowels to be specified for the harmonic feature and therefore opaque to harmony. How do we account for the unexpected transparency of neutral vowels derived from disharmonic vowels? I suggest that the solution to this problem lies in viewing transparency not as an arbitrary property of representations, as it is in the prespecification model, but rather as a logical consequence of the structure of phonemic inventories.

Our intuition is that underlying *i* in Uyghur is neutral with respect to back harmony precisely because it lacks a [+back] counterpart *ɨ*. This fact does not change if the *i* happens to derive from another vowel, but the prespecification theory of Clements and Sezer 1982 misses this parallelism because it requires underlying *i* to be underspecified for [back], but derived *i* to be specified as [-back]. In other words, the prespecification analysis misses the connection between [*i*] produced by Raising and [*i*] derived from underlying /*i*/. What is called for is a theory of harmony that evaluates the role of the *i* in the vowel system as a whole, regardless of its origins.

Calabrese's 1995 theory of sensitivity does just this, allowing us to account straightforwardly for the Uyghur data. In Calabrese's theory rules are specified as sensitive to contrastive, marked, or all feature specifications. In this system, the Uyghur rule of [back] harmony is analyzed as being sensitive only to contrastive [back] specifications. The rule therefore ignores segments that are not contrastive for [back] such as the neutral vowel *i*, which in Uyghur lacks a [+back] counterpart *ɨ*. Crucially, this holds for [*i*] whether it results from underlying /*i*/ or from low vowels that have undergone Raising. (Note that this analysis also accounts for the transparency of underlying *i*, which at the outset of this paper we assumed to be underlyingly specified as [-back].) We therefore correctly predict that the -*či*- allomorph of -*čä*- for example should be transparent to [back] harmony, because its *i* is not contrastive for the feature [back].

Let us consider how this analysis works for the forms *äswibiγä*, *kitapčida*, and *näyčidä*. For *äswibiγä* I assume the underlying representation in (12), repeated here as (27a). In (27b) we can see that cyclic VH cannot propagate [-back] from the first root vowel to the suffix, because it is blocked by the contrastive [+back] specification of the second root vowel. The latter vowel does not propagate its [+back] value either, because VH spreads only [-back] specifications. The [-back] value of the -*i*- does not spread to the harmonic suffix because it is not contrastive. As a result, the harmonic suffix emerges from the cyclic rule block without a [back] specification (27c). In the post-cyclic block Raising applies first, and changes the second root vowel to *i* (27d). Post-cyclic VH then spreads the [-back] specification of the first root vowel to the harmonic suffix, ignoring non-contrastive [-back] specification of the two intervening *i*'s (27e). (To make it clear that these features are not visible to the rule, I have underlined them.) The linked configuration subsequently splits into two, yielding the surface form in (27f).

(27) derivation of /*äswab-i-GA*/ → [*äswibiγä*]

a. underlying form *ä s w a b - i - G A*
| | |
[-bk] [+bk] **[-bk]**

b. cyclic VH *ä s w a b - i - G A*
| * |
[-bk] [+bk] **[-bk]**

c. cycle output *ä s w a b - i - G A*
| | |
[-bk] [+bk] **[-bk]**

d. post-cyclic Raising [+high]
|
ä s w i b - i - G A
| | |
[-bk] **[-bk]** **[-bk]**

e. post-cyclic VH

[+high]

ä s w i b - i - G A

[-bk] **[-bk]** **[-bk]**

f. surface form

[+high]

ä s w i b - i - γ ä

[-bk] [+bk] [-bk] [-bk]

For *kitapčida* the derivation proceeds in an analogous manner, which I have outlined in (28).

(28)

underlying form:	**[[[*kita:b*]-*čä*]-*DA*]**	**rule**	**comments/output**
cycle 1	[*kita:b*]	VH	—
cycle 2	[[*kita:b*]-*čä*]	VH	— (the [-back] specification of the root *i* is non-contrastive and therefore does not spread)
cycle 3	[[[*kita:b*]-*čä*]-*DA*]	VH	— (-*čä*- is non-cyclic and therefore does not trigger cyclic VH)
non-cyclic block	*kita:bčäDA*	Raising	*kita:bčiDA*
		VH	— (no contrastive [-bk] specifications available to spread to the suffixal *A*)
		default [+bk]	*kita:bčiDa*
surface form:			[*kitapčida*]

For *näyčidä* (from underlying /näy-çä-DA/) the derivation works in the same way as in (28), save that post-cyclic VH spreads the contrastive [-back] specification to the harmonic suffix vowel through the intervening non-contrastive *i*.

To sum up, I have suggested that a satisfactory account for the facts of Uyghur vowel harmony must have the structure in (29).

(29) Uyghur Vowel Harmony (final formulation)

i. Non-alternating vowels are underlyingly specified for [back].

ii. Harmonic vowels are underlyingly unspecified for [back].

iii. Vowel Harmony spreads contrastive [-back] specification(s) of the root outward to affixes within the same word.
iv. Non-contrastive [-back] specifications are ignored as potential triggers and targets of Vowel Harmony; hence neutral vowels neither trigger nor block VH.
v. Though [+back] specifications do not spread, they do block propagation of [-back] specifications through them. (In other words, [+back] is not underspecified.)
vi. Vowel Harmony applies in both the cyclic and post-cyclic rule blocks.
vii. Vowel Harmony is feature-filling, and therefore does not apply to segments that are already specified for the harmonic feature.
viii. Raising is non-cyclic; within the post-cyclic stratum it precedes Vowel Harmony.
ix. Vowels that have not received a [back] specification during the course of the derivation are assigned the value [+back] by a redundancy rule.

An interesting prediction of the theory proposed here is that there should be no language that is exactly like Uyghur save that neutral vowels derived from disharmonic vowels remain disharmonic. This outcome is possible (and in fact required) in the prespecification analysis of Clements and Sezer 1982[5], but is impossible in the inventory-based theory of sensitivity espoused here, which requires that all neutral vowels—whether underlying or derived—behave in the same manner. Thus if underlying neutral vowels are transparent, derived neutral vowels must be transparent as well; if underlying neutral vowels are opaque, so must derived neutral vowels be.

5. OT analyses

The analysis in (29) does not require any formal machinery that is not independently motivated in the derivational literature. Since derivational phonology and hence many of the tenets in (29) have been abandoned in recent years in favor of the constraint-based perspective of Optimality Theory, though, we must consider whether the same range of facts can be accounted for in OT.

5.1. Pulleyblank

Let us begin with the fairly standard OT approach to vowel harmony developed by Pulleyblank (1993, 1996). Pulleyblank assumes that harmonic segments are underlyingly unspecified for the harmonic feature, and employs a combination of Alignment, Markedness, and Faithfulness constraints to determine the ways in which these segments receive their surface specifications. The facts set out thus far in this paper can be accounted for with the following constraints in Pulleyblank's system (cf. Pulleyblank 1996:328):

[5] The same reasoning holds for derivational implementations of Inkelas' theory of underspecification, according to which "only predictable, alternating structure is underspecified" (Inkelas, Orgun, and Zoll 1998:21).

(30) i. *ɨ[6]: All non-low back vowels must be [+round].

i. **ALIGN([-back]$_{Root}$, PrWd, R)**: Align every [-back] specification in a Root with the right edge of a Prosodic Word.

ii. **MAX$_{[-back]}$**: Do not delete [-back] specifications

iii. **DEP$_{[-back]}$**: Do not insert [-back] specifications.

iv. **MAXPATH**: Do not delete association lines.

v. **DEPPATH**: Do not insert association lines.

Pulleyblank's model includes a number of subtleties that do not affect the basic line of argumentation to be presented here:

(31) i. Only one value for the harmonic feature is represented in the tables. All segments not specified for that feature value in surface representations are assumed to have the opposite value. (Pulleyblank 1996:325)

ii. Alignment violations are computed locally rather than globally; in other words, a non-aligned element only engenders asterisks equal to the number of non-aligned syllables (including itself) lying between it and the next specification for the feature under consideration. (Pulleyblank 1996:325-6)

Figures (32-40) show how the constraints in (30) in tandem with the assumptions in (31) select the desired surface forms.[7]

(32) /xät-lAr/ 'letter-plural' → [xätlär]

[-bk] /xät-lAr/	AlignR	Max$_{[-back]}$	Dep$_{[-back]}$	MaxPath	DepPath
☞ [-bk] xätlär					*
[-bk] [-bk] xätlär	*!		*	*	
[-bk] xätlar	*!				
χatlar	*!	*		*	

[6] In Pulleyblank's system this would technically be expressed as a grounding condition of the form "if [+back, -low] then [+round]"; I use the formulation "*ɨ" for typographical parsimony.

[7] I ignore here the fact that certain consonants also undergo VH, as this fact is not directly relevant to our concerns. I also ignore the fact that the constraints employed here should allow a gapped configuration to win; this issue is discussed at length in Pulleyblank 1996.

(33) /at-lAr/ ‘horse-plural’ → [atlar]

/at-lAr/	AlignR	$Max_{[-back]}$	$Dep_{[-back]}$	MaxPath	DepPath
[-bk] ätlär			*!		**
[-bk] [-bk] ätlär			**!		**
[-bk] atlär			*!		*
☞ atlar					

(34) /til-lAr/ ‘tongue-plural’ → [tillar]

/til-lAr/	AlignR	$Max_{[-back]}$	$Dep_{[-back]}$	MaxPath	DepPath
[-bk] tillär			*		**!
[-bk][-bk] tillär			**!		**
[-bk] ☞ tillar			*		*

(35) /yol-imiz-GA/ ‘road-1pl-dative’ → [yolimizʁa]

/yol-imiz-GA/	AlignR	$Max_{[-back]}$	$Dep_{[-back]}$	MaxPath	DepPath
[-bk] yolimizγä			*		***!
[-bk] ☞yolimizʁa			*		**

(36) /bala-lAr/ ‘child-plural’ → [balilar][8]

/bala-lAr/	AlignR	$Max_{[-back]}$	$Dep_{[-back]}$	MaxPath	DepPath
[-bk] balilär			*		**!*
[-bk] ☞ balilar			*		*

8 In the tables that follow I do not formulate the constraint(s) required to produce Raising, because this is not directly relevant for our purposes.

(37) /äswab-i-GA/ 'tool-3sgposs-dative' → [äswibiγä]

[-bk] /äswab-i-GA/	AlignR	Max[-back]	Dep[-back]	MaxPath	DepPath
[-bk] ☞ äswibiγä					***
[-bk] äswibiʁa	*!				**

(38) /adäm-i-GA/ 'man-3sgposs-dative' → [adimiγä]

[-bk] /adäm-i-GA/	AlignR	Max[-back]	Dep[-back]	MaxPath	DepPath
[-bk] ☞ adimiγä					**
[-bk] adimiʁa	*!				*

(39) /kita:b-čä-DA/ 'book-small-locative' → [kitapčida]

[-bk] kita:b-čä-DA	AlignR	Max[-back]	Dep[-back]	MaxPath	DepPath
[-bk] [-bk] ☞kitapčida			*		*
[-bk] [-bk] kitapčidä			*		**!

(40) /näy-čä-DA/ 'flute-small-locative' → [näyčidä]

[-bk] [-bk] näy-čä-DA	AlignR	Max[-back]	Dep[-back]	MaxPath	DepPath
[-bk] ☞näyčidä		*		*	**
[-bk] näyčida	*!	*		*	*

As can be seen in (32) - (40), the constraint ranking in (30) is sufficient to produce all of the forms specifically mentioned in this paper thus far. However, it is not able to account for all of the *types* of forms that the analysis in (29) is able to explain. Consider for example the form in (41):

(41) Problems for the Pulleyblank analysis

underlying form	**surface form**	**gloss**
kita:b-čä-m-DA	kitapčämdä	book-small-1sgposs-locative

Figure (41) shows that the harmonic suffix following the non-cyclic disharmonic suffix -*čä*- agrees in backness with it; this is the standard behavior of non-cyclic suffixes that do not undergo Raising. The analysis in (29) accounts for forms of this type in a straightforward manner, with no additional statements or stipulations required.

Now let us consider how the same facts would fare in the constraint schema in (30):

(42) /kita:b-čä-m-DA/ → [kitapčämdä]

[-bk] kita:b-čä-m-DA	AlignR	Max$_{[-back]}$	Dep$_{[-back]}$	MaxPath	DepPath
[-bk] [-bk] ☞kitapčämdä			*		**!
[-bk] [-bk] ☠ kitapčämda			*		*

The hand (☞) represents the candidate that actually wins; the skull and crossbones (☠) represents the candidate that should win according to the constraint schema. The striking fact revealed by (42) is that the constraint ranking that did so well in accounting for the basic facts in (32) - (40) is unable to derive what in derivational theories is a completely straightforward and unsurprising outcome: harmonic vowels surface as [-back] after *ä*. The reason that the schema in (30) does not fare well with forms like *kitapčämdä* is that the [-back] disharmonic vowel *ä* is not part of the root, and therefore does not engender any violations of AlignR when it fails to propagate rightwards. In order to rectify this situation we would have to alter the formulation of the AlignR constraint so that it included *all* underlying [-back] specifications, even in suffixes. If we make this modification, however, we lose the ability to account for forms like *kitapčida* for the reasons outlined in (43):

(43) **underlying form** **/kita:b-čä-DA/** (**[-bk]** on *ä*) **evaluation by AlignR([-back], PrWd)**

candidate outputs: [kitapčida] ([-bk] [-bk]) — Underlying [-back] specification is misaligned from the right edge of the Prosodic Word by one syllable; one asterisk assessed.

[kitapčidä] ([-bk] [-bk]) — Underlying [-back] specification is perfectly aligned with the right edge of the Prosodic Word; no asterisk assessed.

Since AlignR is the constraint ranked the highest in the schema in (30), the fact that it is violated by *kitapčida* but not by *kitapčidä* guarantees that *kitapčidä* will win, which is not the outcome we want.

As it turns out, *no* reasonable modification of the OT scheme in (30) (e.g. formulating AlignR so that it refers only to surface [-back] specifications; specifying neutral vowels as [-back] underlyingly; assessing Align violations absolutely vs. gradiently) can account for the range of Uyghur facts adduced in this paper without major alterations such as the addition of levels of derivation. As I discuss in more detail below, though, the addition of levels to OT fatally weakens the theory by depriving it of its primary advantage over derivational models.

5.2. Cole and Kisseberth

Cole and Kisseberth 1994 resembles Pulleyblank 1996 in employing a more static conception of harmony wherein the role of autosegmental spreading is minimized. Whereas Pulleyblank allows Gen to produce multiply linked structures via spreading, though, Cole and Kisseberth employ only feature insertion and deletion. The other important way in which their model differs from Pulleyblank 1996 and most other theories of harmony is in its reification of the harmony domain as a phonological entity. Let us now see if these modifications to the conventional OT treatment of harmony fare any better with the Uyghur facts.

Cole and Kisseberth make the following assumptions that will be relevant for Uyghur (1994:102):

(44) Relevant assumptions in Cole and Kisseberth's model of Vowel Harmony

i. *Features are privative.* In Cole and Kisseberth's system, Uyghur Vowel Harmony involves the feature Palatal (equivalent to traditional [-back]).

ii. *Full specification.* Segments are fully specified in underlying representations unless there is no evidence for an underlying specification (e.g. in harmonic suffix vowels).

iii. *Harmony is insertion.* Harmony is not modeled as autosegmental spreading; there is no multiple association between segments and harmonic features.

Crucially, assumption (44ii) has to be modified so that neutral vowels are underlyingly unspecified for the harmonic feature. If this were not the case, a neutral root like *til* 'tongue' would be predicted to behave identically to a [-back] harmonic root like *xät* 'letter', since both would be underlyingly specified as [-back] (or [Palatal] in Cole and Kisseberth's system) (compare the forms in (4)). In the tables that follow, we represent these underspecified neutral vowels with capital letters, e.g. *tIl*.

Given the assumptions in (44) and the above stipulation concerning neutral vowels, the following constraints are necessary to account for the basic Uyghur facts in Cole and Kisseberth's model:

(45) Relevant constraints for Uyghur VH (based on Cole and Kisseberth 1994)

i.	**CLASH**	Non-low back unrounded vowels are not allowed.
ii.	***INSERT [PALATAL]**	Every [Palatal] specification in the output must have a correspondent in the input. (Equivalent to Dep$_{[\text{-back}]}$ in conventional OT.)
iii.	***<PALATAL>**	Every [Palatal] specification in the input must have a correspondent in the output. (Equivalent to Max$_{[\text{-back}]}$ in conventional OT.)
iv.	**BA-L**	The left edge of every segment anchoring a [Palatal] specification in the underlying representation must be aligned with the left edge of a Palatal domain in the surface representation. (In Cole and Kisseberth's terminology, this Basic Alignment constraint is Align(Anchor-s, L; F-domain, L).)
v.	**BA-R**	Align(Anchor-s, R; F-domain, R)
vi.	**WSA-R**	The right edge of every Palatal domain must be aligned with the right edge of a Prosodic Word. (In Cole and Kisseberth's terminology, this Wide Scope Alignment constraint is Align(F-domain, R; PrWd, R).)
vii.	**EXPRESS [PALATAL]**	The feature [Palatal] must be affiliated with every anchor in a Palatal domain.

Now let us consider how these constraints deal with some of the basic products of Uyghur vowel harmony. In order to account for the classes of forms in (32-38) we require the ranking in (46).

(46) CLASH >> WSA-R >> BA-R >> BA-L >> EXPRESS >> *INSERT

The tables in (47) - (53) demonstrate how this ranking produces the desired outputs for basic cases. (Vowels underlyingly unspecified for the harmonic feature are written with capital letters.)

(47) Front vowel + harmonic suffix: /kät-lAr/ 'letter-plural' → [xätlär]

UR: xät-lAr	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ (xätlär)			*			*
(xät)(lär)		*				*
(xät)lar		*				
(xätlar)			*		*	
χatlar			*	*		

(48) Back vowel + harmonic suffix: /at-lAr/ 'horse-plural' → [atlar]

UR: at-lAr	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ atlar						
at(lär)						*
(ät)lar		*				*
(ätlär)						**
(atlar)					**	

(49) Neutral vowel + harmonic suffix: /tIl-lAr/ 'tongue-plural' → [tillar]

UR: tIl-lAr	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ tillar						*
(tillar)					*	*
(tillär)						**
tɨllar	*					
(til)lar		*				*
(til)(lär)		*				**

(50) Bk V + neutral V + harmonic V: /yol-ImIz-GA/ 'road-1pl-dative' → [yolimizʁa]

/yol-ImIz-GA/	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ yolimizʁa						
yo(limizʁa)					*	
(yolimizʁa)					**	
yo(limiz)ʁa		*				
yo(limizgä)						*
(yölimizgä)						**
yo(li)(miz)ʁa		**				

(51) Back V + derived neutral V + harmonic V: /bala-lAr/ 'child-plural' → [balilar]

UR: bala-lAr	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ balilar						*
(balilar)					**	*
ba(li)lar		*				*
ba(lilär)						**
ba(lilar)					*	*

(52) Disharmonic back-V-final root + neutral V + harmonic V:
/äswab-I-GA/ 'tool-3sgposs-dative' → [äswibiγä]

/äswab-I-GA/	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ (äswibiγä)			*			***
(äs)wibiʁa		*				**
äswibiγä			*	*		***
aswibiʁa			*	*		**
(äswibi)ʁa		*	*			**
(aswibiʁa)			*		**	**

(53) Disharmonic front-V-final root + neutral V + harmonic V:
/adäm-I-GA/ 'man-3sgposs-dative' → [adimiγä]

/adäm-I-GA/	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ a(dimiγä)			*			**
adimi(γä)			*	*		**
adimiʁa			*	*		*
adimiγä			*	*		**
a(di)(miγä)		*				**
a(dimiʁa)			*		*	*

The above tables show that the ranking in (46) is able to account for the cases in (47) - (53), provided we assume that neutral vowels are underlyingly unspecified for the harmonic feature.

As was the case with Pulleyblank's system, though, Cole and Kisseberth's system is unable to derive the correct surface forms of words containing derived neutral vowels in non-cyclic suffixes following [+back] roots, as shown in (54).

(54) /kIta:b-čä-DA/ 'book-small-locative' → [kitapčida]

/kIta:b-čä-DA/	CLASH	WSA-R	BA-R	BA-L	EXPRESS	*INSERT
☞ kitapčida			*	*		*
☠kitap(čidä)			*			**
kitap(či)da		*				*
(ki)tap(čida)		*	*		*	*
(kitapčidä)			*	*	*	**
(kitäpčidä)			*	*		***

As should be clear from the table in (54), the correct output *kitapčida* can only be obtained by ranking *INSERT above BA-L. This ranking would however be unable to derive simple cases of harmonic suffixes agreeing with [-back] harmonic roots, as with /xät-lAr/ → [xätlär], because the ranking *INSERT >> BA-L would favor candidates that (all else being equal) avoid inserting

[-back]. For example, the actual winning candidate in (47), (xätlär), would lose to the incorrect output *(xätlar), because the latter is identical to the former save for the fact that it does not insert any [-back] specifications and therefore wins the evaluation by *INSERT.

Cole and Kisseberth's theory therefore fails to overcome the problems encountered by Pulleyblank's theory. As Pulleyblank 1996 points out, moreover, Cole and Kisseberth's theory also falls short insofar as it adds a new phonological entity, the harmony domain, which is not necessary in other theories of harmony.

5.4. Summary of OT analyses

We have seen, then, that two representative OT accounts of harmony, Pulleyblank 1996 and Cole and Kisseberth 1994, are unable to account for the range of Uyghur facts. It should be clear from the discussion in the previous two sections that in fact *no* monostratal implementation of OT will be able to account for the Uyghur data, no matter how many (reasonable) constraints it posits.

A constraint-based theory of harmony may well be able to churn out the correct surface forms via judicious use of levels, Output-Output constraints, or Sympathy, but taking recourse to these devices deprives OT of what I believe to be its only significant advantage over derivational theories, which is the avoidance of supposedly unmotivated levels of representation and byzantine computations. Let us consider these options individually.

5.4.1. Multistratal OT

Faced with the general problem of opaque interactions between phonological processes, most OT phonologists have in recent years abandoned the monostratal conception of OT and reintroduced the traditional derivational notion of levels and level ordering. Some phonologists (including Orgun, Koskenniemi, Rubach 2000, and in a less overt way Ní Chiosáin and Padgett 1997) have realized that this step runs the risk of making OT just as stipulative as its derivational predecessors, and have therefore attempted to limit their system to two well-defined levels corresponding to the traditional lexical and postlexical strata. As McCarthy 1997 points out, though, the two-level approach is unable to deal with derivations where an intermediate level of representation is crucial, as in the famous Hebrew *deše* case.

Other phonologists (notably Goldsmith, Lakoff, and Kiparsky 2000) have been led to emply three or more levels of representation within a constraint-based framework. McCarthy notes that these multistratal versions of OT trivialize strata, permit implausible ranking inconsistencies between strata, and "ignore [the] main issue that derivations present for OT" (1997:4).

We can conclude, then, that a multistratal implementation of OT is not on the right track. This leaves only two possibilities with which OT can account for opacity and cases of the Uyghur type: Output-Output faithfulness (Benua) and Sympathy (McCarthy 2000).

5.4.2. Output-Output faithfulness

Benua attempts to use Output-Output faithfulness constraints to derive certain types of opacity. As McCarthy 1997:5 points out, though, this cannot work in cases where there is no form elsewhere in the relevant paradigm to force the desired alternation. In the case of Hebrew *deše*, for example, there is no form elsewhere in the nominal paradigm to force the insertion of the epenthetic *e*. The same argument holds for the Uyghur case; minimal pairs like *kitapčida* vs. *adimiγä* cannot be explained in terms of more basic members of the paradigm. (For further arguments against Output-Output faithfulness as an explanation of opacity see Hale, Kissock, and Reiss 1998 and Rubach 2000.)

5.4.3. Sympathy

The last possible means at OT's disposal for dealing with opacity is Sympathy (McCarthy 2000). Sympathy suffers a number of theoretical and empirical weaknesses, and therefore fares no better than the alternatives already considered. First of all Sympathy is inherently derivational, as Idsardi 1998 has noted: the selection of the sympathetic candidate crucially must occur before the selection of the actual winner. Idsardi also demonstrates that Sympathy creates chaos: a phonological system with several independent opaque interactions requires the postulation of a number of sympathetic constraints, whose interactions leave us unable to account for certain basic output types. Moreover, Rubach 2000 has shown that Sympathy is unable to account for the opaque interactions found in the phonological behavior of vowel sequences in Slavic languages. Finally, it is not at all clear that Sympathy can account for the Uyghur cases discussed in this paper.

To sum up this section, no modification of OT appears to be able to handle opacity and facts of the Uyghur type while simultaneously retaining the advantages of OT. A derivational theory of the sort outlined in (29), on the other hand, is able to account for the complicated Uyghur facts in a straightforward manner, using only machinery that is amply and independently motivated in the phonological literature. Such a theory is also quite capable of dealing with opacity via rule ordering, as is well known. Unless it can be demonstrated that OT is capable of accounting for the Uyghur facts and for opacity in an equally principled and efficient manner, which I have suggested is not possible, we must conclude that a serial approach to phonology is to be preferred over a parallel one.

6. Conclusions

In this paper I have presented three main points of interest, one empirical and two formal. The novel empirical component of this paper is the examination of neutral vowels derived from disharmonic vowels. Though previous treatments of vowel harmony have not considered this topic, they do in fact make predictions about the behavior of derived neutral vowels: in the prespecification model (Clements 1976, Clements and Sezer 1982, Clements 1987, etc.) neutral vowels derived from harmonic vowels should be transparent, and neutral vowels derived from disharmonic vowels should be opaque. In Output-driven models, on the other hand, all surface neutral vowels should behave in the same manner. I have argued that the Uyghur facts show both of these sets of predictions to be incorrect, which leads to two important conclusions concerning the formal structure of phonological theory: (i) harmony is sensitive to inventory-based contrast, rather than representational encoding of contrast; (ii) a derivational theory incorporating this notion of contrast is to be preferred over output-driven theories of phonology.

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