# When is derived [i] transparent? A subtractive approach to Uyghur vowel harmony*

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## 1. Introduction

Phonological patterns often seem to ignore redundant features and apply only to contrastive ones. Two types of theoretical explanations have been advanced to account for this fact. One of these, which we will refer to as the subtractive approach, is based on making phonological representations sparser: redundant features are ignored because they are systematically absent from at least some well-defined part of the phonological computation—generally including, but not always limited to, underlying representations. Proponents of this approach include Archangeli (1988), Dresher (2009, 2013, 2015), Hall (2007, 2017), and Mackenzie (2009, 2011, 2013). The other type of explanation is additive: it enriches the information content of phonological representations by positing that not only are both contrastive and redundant features specified, the phonological computation is able to distinguish between them. This is the approach taken by Calabrese (1995), Halle, Vaux, and Wolfe (2000), Vaux (2000), and Nevins (2010, 2015), among others.

Uyghur vowel place harmony presents an interesting set of patterns for exploring the difference between these two approaches to the role of contrast. Underlying /i/, which has no back counterpart, is transparent to harmony. In suffixes, [i] derived from underlying harmonic vowels is also transparent; in roots, [i] derived from back vowels is transparent, but [i] derived from front vowels is not. Halle, Vaux, and Wolfe (2000) and Vaux (2000) propose an additive account of these facts; in this paper, we show that the more parsimonious subtractive approach yields a principled alternative account that offers new insights into the harmony patterns.

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## 2. The data to be accounted for

### 2.1 The basic pattern of harmony and transparency

The vowel inventory of Uyghur is shown in (1). As in Finnish, which has the same inventory, vowels that differ from each other only in backness participate in harmony: /y/ is partnered with /u/, /ø/ with /o/, and /æ/ with /ɑ/.

(1) *The vowel inventory of Uyghur*

| | FRONT | | BACK | |
|---|---|---|---|---|
| | UNRND | ROUND | UNRND | ROUND |
| HIGH | i | y | | u |
| MID | e | ø | | o |
| LOW | æ | | ɑ | |

Harmony propagates rightward from roots to suffixes, as illustrated in (2)–(5) with examples from Hahn (1991a), Schwarz (1992), Vaux (2000), D'Arcy (2004), and Csató and Uchturpani (2010). The suffix vowels alternate to match the frontness or backness of the vowel in the root.

(2) *Front stems plus causative* -dUr

a. yn-dyr 'appear'+CAUS.
b. søk-tyr 'take apart'+CAUS.
c. ʧæk-tyr 'smoke'+CAUS.

(3) *Back stems plus causative* -dUr

a. sun-dur 'break'+CAUS.
b. qop-tur 'get up'+CAUS.
c. bɑq-tur 'raise'+CAUS.

(4) *Front stems plus plural* -lAr

a. jyz-lær 'face'+PL.
b. køl-lær 'lake'+PL.
c. xæt-lær 'letter'+PL.

(5) *Back stems plus plural* -lAr

a. pul-lɑr 'money'+PL.
b. jol-lɑr 'road'+PL.
c. ɑt-lɑr 'horse'+PL.

Unpaired /i/ can occur in both front and back stems, as in (6) and (7), and is transparent to harmony (data from Schwarz 1992). (The other unpaired vowel, /e/, occurs mostly in loanwords and as a result of umlaut.) Phonetically, the vowel transcribed as /i/ can be realized as any unrounded vowel of at least the height of [e] or [ɤ], with its frontness or backness depending largely on the surrounding consonants; the default realization is [ɪ] (Hahn 1991a: §4.1.1).

(6) */i/ in front stems plus causative* -dUr

a. iʃæn-dyr 'believe'+CAUS.
b. ʧiʃlæʃ-tyr 'mesh, bite.RECIP'+CAUS.
c. zæʔiplæʃ-tyr 'weaken'+CAUS.

(7) */i/ in back stems plus causative* -dUr

| | | |
|---|---|---|
| a. | ɑrtil-dur | 'have loaded on'+CAUS. |
| b. | zitʃlɑʃ-tur | 'become close'+CAUS. |
| c. | huʃsizlɑn-dur | 'lose consciousness'+CAUS. |

The transparency of /i/ in suffixes is illustrated in (8) and (9) with data from Vaux (2000):

(8) *Front stems plus 1pl. possessive* -imiz *plus dative* -GA

| | | |
|---|---|---|
| a. | jyz-imiz-gæ | 'face'+'our'+DAT. |
| b. | køl-imiz-gæ | 'lake'+'our'+DAT. |

(9) *Back stems plus 1pl. possessive* -imiz *plus dative* -GA

| | | |
|---|---|---|
| a. | pul-imiz-ʁɑ | 'money'+'our'+DAT. |
| b. | jol-imiz-ʁɑ | 'road'+'our'+DAT. |

Stems containing only neutral vowels show two different patterns. Some take front suffixes, as in (10), but the majority take back suffixes, as in (11) (data from Pattillo 2013, Schwarz 1992, Lindblad 1990).

(10) *Front 'neutral' stems*

| | | |
|---|---|---|
| a. | bilim-gæ | 'knowledge'+DAT. |
| b. | kir-gæ | 'dirt'+DAT. |
| c. | birik-tyr | 'join, tie'+CAUS. |
| d. | tʃekin-dyr | 'retreat'+CAUS. |

(11) *Back 'neutral' stems*

| | | |
|---|---|---|
| a. | sinip-qɑ | 'classroom'+DAT. |
| b. | til-ʁɑ | 'tongue'+DAT. |
| c. | tin-dur | 'feel peace'+CAUS. |
| d. | siʁiʃ-dur | 'contain'+CAUS. |

This leads Hahn (1991a) to say that there is an underlying contrast between /i/ and /ɨ/, neutralized at the surface; Lindblad (1990) and Hahn (1991b) also posit an underlying back counterpart to /e/. The alternative to adding phonemes is to posit morpheme-level specifications—either diacritics or floating features (Vaux 2000).

As Lindblad (1990) and Pattillo (2013) point out, vowel–consonant interactions make it possible in many (though not all) cases to predict which suffixes a neutral-vowel root will take. Velar consonants generally go with front vowels, and uvular consonants with back vowels, as can be seen in the forms of the dative suffix in (8)–(11). Accordingly, we find pairs like the neutral-vowel roots in (12) and (13) (data from Hahn 1991a: 48).

(12)

| | | |
|---|---|---|
| a. | kij-mæ | 'wear'+NEG. |
| b. | kij-gy | 'wear'+DESID. |

(13)

| | | |
|---|---|---|
| a. | qij-mɑ | 'cut'+NEG. |
| b. | qij-ʁu | 'cut'+DESID. |

## 2.2 Non-harmonizing suffixes and derived transparency

There are also some non-harmonizing suffixes. For example, the suffix *-tʃæ* remains front even after back stems, as shown in (14) with examples from Schwarz (1992: 1063). (This suffix can have a diminutive, approximative, or similative interpretation. Schwarz treats it as three suffixes, but we assume—though not crucially—that its meanings are unifiable.)

| | | | | |
|---|---|---|---|---|
| (14) | a. | kitɑp-ʧæ | 'booklet' | ('book'+*ʧæ*) |
| | b. | uzun-ʧæ | 'longish' | ('long'+*ʧæ*) |
| | c. | ujʁur-ʧæ | 'Uyghur-like' | ('Uyghur'+*ʧæ*) |
| | d. | loji-lɑr-ʧæ | 'bureaucratic' | ('bureaucrat'+PL.+*ʧæ*) |

Suffixes following *-ʧæ* also show front harmony. This is illustrated in (15), where the locative suffix after *-ʧæ* has a front vowel, regardless of the vowels in the root (data from Hahn 1991b: 94).

| | | | | |
|---|---|---|---|---|
| (15) | a. | næj-ʧæ-m-dæ | 'in my little flute' | ('flute'+*ʧæ*+1SG.POSS.+LOCATIVE) |
| | b. | kitɑp-ʧæ-m-dæ | 'in my booklet' | ('book'+*ʧæ*+1SG.POSS.+LOCATIVE) |

In medial open syllables, the low vowels /æ/ and /ɑ/ raise to [i]. When the raised vowel is in a harmonic root, raising has no effect on harmony, as shown in (16) with examples from Hahn (1991a: 52–53). (Disharmonic roots are discussed below in §5.1.)

| | | | | | |
|---|---|---|---|---|---|
| (16) | a. | tø.pæ | 'peak' | tø.p**i**˗lær | 'peak'+PL. |
| | | | | tø.p**i**˗l**i**.r-i | 'peak'+PL.+3PL.POSS |
| | b. | sæ.pær | 'journey' | sæ.p**i**.r-im | 'journey'+1SG.POSS. |
| | c. | bɑ.lɑ | 'child' | bɑ.l**i**˗lɑr | 'child'+PL. |
| | d. | je.zɑ | 'village' | je.z**i**˗dɑ | 'village'+LOCATIVE |

When raising applies to the suffix *-ʧæ,* however, the raised vowel becomes transparent to harmony; contrast (15b) with (17b), also from Hahn (1991b: 94).

| | | | | |
|---|---|---|---|---|
| (17) | a. | næj-ʧi-dæ | 'in the little flute' | ('flute'+*ʧæ*+LOCATIVE) |
| | b. | kitɑp-ʧi-dɑ | 'in the booklet' | ('book'+*ʧæ*+LOCATIVE) |

## 3. Transparency and contrast: The two approaches

Phonological representations can make a connection between the transparency of /i/ and the fact that it does not contrast with a back counterpart. In the subtractive approach we pursue below, this means that /i/ is simply not specified for place; in the additive approach of Halle, Vaux, and Wolfe (2000) and Vaux (2000), /i/ does have a place specification, but this specification is identifiable as redundant, so that it can be ignored by harmony.

### 3.1 The additive approach

The additive approach could be implemented by adding a meta-featural specification distinguishing contrastive features from redundant ones. Here, we will represent this by writing redundant features in *italic* type. In this approach, some rules are able to see all features; other rules, such as harmony, can see only contrastive (non-italicized) features.

However, Halle, Vaux, and Wolfe's (2000) analysis of derived transparency in Uyghur shows that the additive approach has to be more complicated than that. The contrastive or

redundant status of a feature cannot be established once and for all at the beginning of the derivation; rather, it must be continuously reevaluated as the derivation progresses. This is schematized in (18). The underlying [−back] specification on /æ/ is contrastive, but when open-syllable raising applies, it must be treated as a redundant feature of the resulting [i], rendering it invisible to the harmony rule.

(18) *Schematic derivation of transparent raised [i] in the additive approach*

| æ | | i | | i |
|---|---|---|---|---|
| −high | | +high | | +high |
| +low | | −low | | −low |
| −back | → | −back | → | *−back* |
| −round | | −round | | −round |
| … | | … | | … |
| | OPEN-σ RAISING | | REASSESS CONTRAST | |

In Halle, Vaux, and Wolfe's approach, then, the status of a feature cannot simply be read from the representation itself. Instead, it must be assessed with reference to the inventory, or to the marking statements (Calabrese 1995) that constrain the inventory.

### 3.2 The subtractive approach

While the additive approach requires rules to consult marking statements to know what features to ignore, the Uyghur facts also present a potential challenge for a subtractive approach.

In the subtractive approach, redundant features are underlyingly absent, not just marked as invisible to certain rules. Underlying /æ/ must be specified for place, since it participates in harmony and contrasts with /ɑ/. The question for the subtractive approach is, is there a principled reason for the fact that raising /æ/ to [i] makes it transparent to harmony, as if unspecified for frontness?

We believe that there is. As D'Arcy (2004) points out, raising neutralizes the underlying contrast between /æ/ and /ɑ/. Raising is a form of reduction, in both the acoustic and the formal senses of the term. In the acoustic sense, raising reduces the sonority of the affected vowels by making them high. In the formal sense, it can be represented as a reduction in their featural content. In reducing both /æ/ and /ɑ/ to [i], raising need not impose frontness; rather, it simply deletes the place specifications of the vowels altogether (in addition to making them high).

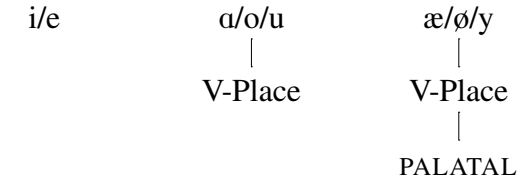
## 4. Implementing the subtractive account

### 4.1 Contrastive representations

In the subtractive approach, neutral vowels lack specifications for place. For non-neutral vowels, we want to be able to say that back is the default place, because stems with only

neutral vowels normally take back suffixes (and because of additional patterns discussed below in §5), but we also need to be able to distinguish default place from lack of place. The representations in (19) accomplish this with privative features in a dependency structure:

(19)

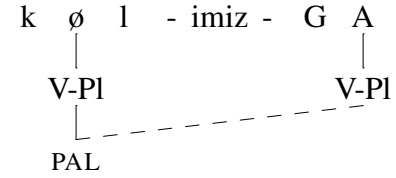



The specifications in (19) can be assigned by Dresher's (2009) Successive Division Algorithm in either of two ways. One possibility is that the V-Place node is an abstract contrastive feature that distinguishes harmonic vowels from neutral vowels (as Hall 2007 does with Laryngeal for consonants). Alternatively, V-Place can be treated as an organizing node that does not itself mark contrasts, but that is present on all and only the segments in which the presence or absence of its dependent feature PALATAL is contrastive (Sandstedt 2018a,b; cf. the Node Activation Condition of Avery and Rice 1989).

### 4.2 Harmony and transparency

Alternating suffix vowels have bare V-Place nodes. Harmony causes a PALATAL feature in a root to be shared by suffixal vowels with V-Place, ignoring any intervening neutral vowels, as in (20).

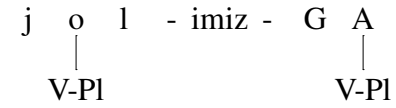
(20)




→ køl-imiz-gæ (8b)

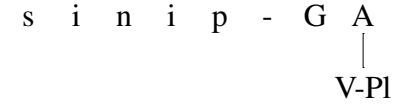
If the root has no PALATAL feature to spread, the suffix vowels surface as back by default. This will be the case if the root vowels are back, as in (21), or neutral, as in (22).

(21)




→ jol-imiz-ʁɑ (9b)

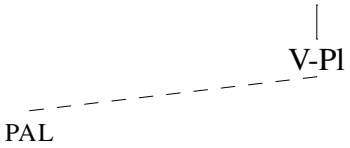
(22)




→ sinip-qɑ (11a)

Neutral-vowel roots that (exceptionally) take front suffixes have a floating PALATAL feature, as in (23).

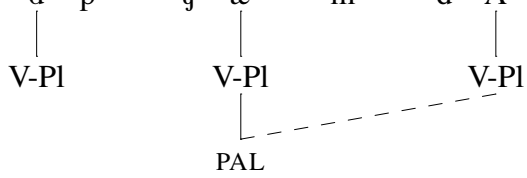
(23) b i l i m - G A → bilim-gæ (10a)




### 4.3 Derived transparency

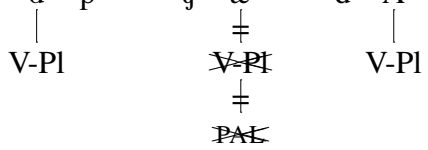
The non-alternating front vowel in the suffix *-ʧæ* has its own PALATAL feature, which it can share with subsequent suffixes.

(24) k i t ɑ p - ʧ æ - m - d A → kitɑp-ʧæ-m-dæ (15b)



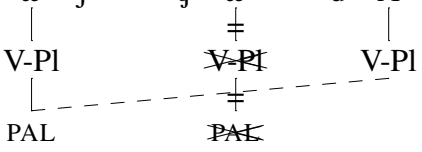

Raising deletes the place features of the raised vowel. When this applies to *-ʧæ,* subsequent suffixes are back by default if there is no PALATAL feature in the root, as in (25).

(25) k i t ɑ p - ʧ æ - d A → kitɑp-ʧi-dɑ (17b)




However, if the root has a front-harmonic vowel, then its PALATAL feature can be shared with the suffix, as in (26).

(26) n æ j - ʧ æ - d A → næj-ʧi-dæ (17a)




Because raising neutralizes the place distinction between /æ/ and /ɑ/, it is natural to represent it as deleting place features. This correctly derives the transparency of the raised vowel in examples like (25) and (26), without requiring that the phonological computation uses marking statements to determine which features harmony is sensitive to.

## 5. Extending the subtractive account

This section shows how our approach deals with further complexities of Uyghur harmony.

### 5.1 Disharmonic roots

Halle, Vaux, and Wolfe (2000: 397–399) argue that the subtractive approach (which they refer to as "prespecification") incorrectly predicts that [i] derived from a harmonic low vowel could retain its harmonic feature:

> In the prespecification analysis [...], the transparency of the raised output of *-ʧæ-* requires postulation of an ad hoc rule that deletes the [−back] specification of the *i*. The problem here is that the prespecification analysis misses the connection between *i* that results from Raising and *i* that comes from underlying *i* [...].
>
> Our theory [...] predicts that there is no language that is exactly like Uyghur, save that the output of raising a disharmonic suffix remains disharmonic.

In our subtractive analysis if Uyghur, the transparency of derived [i] follows from the fact that the process that derives it is one that neutralizes a place contrast, not from the redundancy of place on underlying /i/. It is therefore true that we predict that a similar system could exist in which derived [i] is not transparent.

In fact, there are even instances in Uyghur itself in which an underlying /æ/ that raises to [i] nonetheless transmits its frontness to subsequent vowels. Crucially to Halle, Vaux, and Wolfe's prediction "that there is no language that is exactly like Uyghur, save that the output of raising a disharmonic **suffix** remains disharmonic" [emphasis added], all such cases involve /æ/ in roots.

As Vaux (2000) discusses in more depth, Uyghur has some disharmonic roots, such as those in (27) and (28).

(27) *Front–back roots*

| | | |
|---|---|---|
| a. | æswɑp | 'tool' |
| b. | qæhwɑ | 'coffee' |
| c. | æmmɑ | 'but' |
| d. | ænʤɑn | 'Änjan' (name) |

(28) *Back–front roots*

| | | |
|---|---|---|
| a. | ɑdæm | 'man' |
| b. | ɑʁinæ | 'friend' |
| c. | ɑpæt | 'disaster' |
| d. | roʃæn | 'Roshän' (name) |

In contexts where their second vowel is raised to [i], front–back roots like those in (27) show the expected pattern of derived transparency: the frontness of the first root vowel is shared with harmonizing suffixes, as in (29); data from Vaux (2000).

(29)

| | | |
|---|---|---|
| a. | æswib-i-ɣæ | 'tool'+3SG.POSS+DAT. |
| b. | qæhwi-ɣæ | 'coffee'+DAT. |
| c. | æmmi-lær | 'but'+PL. |
| d. | ænʤin-i-ɣæ | 'Änjan'+3SG.POSS.+DAT. |

But back–front roots like those in (28) also take front suffixes when their second vowels undergo raising, as in (30); data from Vaux (2000).

(30)

| | | | |
|---|---|---|---|
| a. | ɑdim-i-ɣæ | 'man'+3SG.POSS.+DAT. |
| b. | ɑʁini-lær | 'friend'+PL. |
| c. | ɑpit-i-ɣæ | 'disaster'+3SG.POSS.+DAT. |
| d. | roʃin-i-ɣæ | 'Roshän'+3SG.POSS.+DAT. |

In (30), the underlying frontness of the second vowel appears to be retained despite raising. Vaux (2000), working with the same approach to contrast as Halle, Vaux, and Wolfe (2000), accounts for this through rule ordering. Vowel harmony applies cyclically, then raising applies post-cyclically, then harmony applies again post-cyclically. Forms like (30) show front suffixes because cyclic harmony applies before raising; forms like (17b) *kitap-ʧi-da* show back suffixes because *-ʧæ* is non-cyclic, so raising bleeds harmony.

A similar account would also be compatible with the subtractive representations we propose. However, our representations do not require a system in which harmony applies both before and after raising. Instead, they—and our approach to contrast more generally—offer an elegant and principled account of the Uyghur facts that is not dependent on a specific model of the computational system. In the following section, we offer an alternative account of the pattern in disharmonic roots using positional faithfulness (Beckman 1998).

### 5.2 Root faithfulness

There are two asymmetries to account for. One is between front vowels and back vowels: in both (29) and (30), a front root vowel wins out over a back one in determining the place of the suffix vowel. The other is between roots and suffixes: when suffixal /æ/ raises, its frontness is lost, as in (17b), but when root /æ/ raises, its frontness can be preserved on a suffix, as in (30).

The representations in (19), repeated in (31), generate the front–back asymmetry: front vowels have more marked structure.

(31)

| i/e | ɑ/o/u | æ/ø/y |
|---|---|---|
| | V-Place | V-Place |
| | | PALATAL |

The root–suffix asymmetry can be understood in terms of root faithfulness; it is more important to preserve underlying contrasts in roots than it is in affixes (Beckman 1998: ch. 4). Root faithfulness is most easily formalized in Optimality Theory, following Beckman, but could also be adapted into a rule-based framework. (See, e.g., Dresher and van der Hulst 1998, though their focus is on prosodic rather than morphological headedness.) We present below an OT account of Uyghur vowel harmony based on the representations in (31); see Mackenzie and Dresher (2003) for discussion of how contrastive specification can be implemented in OT.

In this account, raising/reduction delinks V-Place, as described above. When this happens to a root vowel with a PALATAL feature, root faithfulness will preserve the PALATAL

feature by associating it to a suffixal V-Place node if possible. A stranded PALATAL feature from a reduced suffix vowel is not protected by root faithfulness, and is simply deleted.

The relevant constraints are shown in (32). Horizontal lines show where one constraint or set of constraints crucially outranks another.

(32) a. DEPLINK[PAL]/ROOT: If PALATAL is linked to a vowel in the root in the output, then PALATAL must be linked to a corresponding vowel in the input.

b. *GAP: PALATAL may not be linked to non-consecutive V-Place nodes.

c. *FLOAT: Each feature must be associated to a segment.

d. REDUCE: Unrounded vowels in medial light syllables cannot have V-Place.

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e. MAXLINK[PAL]: If PALATAL is linked to a vowel in the input, then PALATAL must be linked to a corresponding vowel in the output.

f. MAX-IO[PAL]/ROOT: Each PALATAL feature in a root in the input has a correspondent in the output.

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g. ALIGN[PAL]-RIGHT: Assign a violation mark for each V-Place node that intervenes between the rightmost anchor of a PALATAL specification and the right edge of the word.

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h. DEPLINK[PAL]: If PALATAL is linked to a vowel in the output, then PALATAL must be linked to a corresponding vowel in the input.

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i. MAX-IO[PAL]: Each input PALATAL feature has an output correspondent.

The tableau in (33) shows how harmony spreads PALATAL from a root to a suffix across transparent /i/. Because /i/ has no V-Place node, it is not relevant for *GAP.

(33) *Deriving (8b)* køl-imiz-gæ *'lake'*+*'our'*+DAT.

| k ø l - i m i z - G A (V-Pl, V-Pl, PAL) | DEPLINK[PAL]/RT | *GAP | *FLOAT | REDUCE | MAXLINK[PAL] | MAX[PAL]/RT | AL[PAL]-R | DEPLINK[PAL] | MAX[PAL] |
|---|---|---|---|---|---|---|---|---|---|
| a. ☞ k ø l - i m i z - g æ (V-Pl, V-Pl, PAL) | | | | | | | | * | |
| b. k ø l - i m i z - q ɑ (V-Pl, V-Pl, PAL) | | | | | | | *! | | |
| c. k o l - i m i z - g æ (V-Pl, V-Pl, PAL) | | | | | *! | | | * | |
| d. k o l - i m i z - q ɑ (V-Pl, V-Pl) | | | | | *! | * | | | * |

Given the ranking in (32), back root vowels will block spreading, as in (34), but raising makes them transparent, as in (35).

(34) *Deriving* æswɑp-qɑ *'tool'*+DAT.

| æ s w ɑ b - G A<br>V-Pl V-Pl V-Pl<br>PAL | DEPLINK[PAL]/RT | *GAP | *FLOAT | REDUCE | MAXLINK[PAL] | MAX[PAL]/RT | AL[PAL]-R | DEPLINK[PAL] | MAX[PAL] |
|---|---|---|---|---|---|---|---|---|---|
| a. ☞ æ s w ɑ p - q ɑ<br>V-Pl V-Pl V-Pl<br>PAL | | | | | | | ** | | |
| b. ɑ s w ɑ p - q ɑ<br>V-Pl V-Pl V-Pl | | | | | *! | * | | | * |
| c. æ s w ɑ p - k æ<br>V-Pl V-Pl V-Pl<br>PAL | | *! | | | | | | * | |
| d. æ s w æ p - k æ<br>V-Pl V-Pl V-Pl<br>PAL | *! | | | | | | | ** | |

(35) *Deriving (29a)* æswib-i-ɣæ *'tool'*+3SG.POSS+DAT.

| æ s w ɑ b - i - G A<br>V-Pl V-Pl V-Pl<br>PAL | DEPLINK[PAL]/RT | *GAP | *FLOAT | REDUCE | MAXLINK[PAL] | MAX[PAL]/RT | AL[PAL]-R | DEPLINK[PAL] | MAX[PAL] |
|---|---|---|---|---|---|---|---|---|---|
| a. ☞ æ s w i b - i - ɣ æ<br>V-Pl V-Pl<br>PAL | | | | | | | | * | |
| b. æ s w i b - i - ʁ ɑ<br>V-Pl V-Pl<br>PAL | | | | | | | *! | | |
| c. æ s w ɑ b - i - ʁ ɑ<br>V-Pl V-Pl V-Pl<br>PAL | | | | *! | | | ** | | |

A PALATAL feature from a suffix will not be preserved under raising, as shown in (36).

(36) *Deriving (17b)* kitɑp-ʧi-dɑ *'book'*+*ʧæ*+LOC.

| k i t ɑ p - ʧ æ - d A<br>V-Pl V-Pl V-Pl<br>PAL | DEPLINK[PAL]/RT | *GAP | *FLOAT | REDUCE | MAXLINK[PAL] | MAX[PAL]/RT | AL[PAL]-R | DEPLINK[PAL] | MAX[PAL] |
|---|---|---|---|---|---|---|---|---|---|
| a. ☞ k i t ɑ p - ʧ i - d ɑ<br>V-Pl V-Pl | | | | | * | | | | * |
| b. k i t ɑ p - ʧ i - d æ<br>V-Pl V-Pl<br>PAL | | | | | * | | | *! | |
| c. k i t ɑ p - ʧ æ - d æ<br>V-Pl V-Pl V-Pl<br>PAL | | | | *! | | | | * | |

A PALATAL feature from a root, however, will be realized on a suffix even if raising/reduction prevents it from surfacing on the root vowel, as in (37).

(37) *Deriving (30a)* ɑdim-i-ɣæ *'man'*+3SG.POSS.+DAT.

| ɑ d æ m - i - G A<br>V-Pl V-Pl V-Pl<br>PAL | DEPLINK[PAL]/RT | *GAP | *FLOAT | REDUCE | MAXLINK[PAL] | MAX[PAL]/RT | AL[PAL]-R | DEPLINK[PAL] | MAX[PAL] |
|---|---|---|---|---|---|---|---|---|---|
| a. ☞ ɑ d i m - i - ɣ æ<br>V-Pl V-Pl<br>PAL | | | | | * | | | * | |
| b. ɑ d i m - i - ʁ ɑ<br>V-Pl V-Pl | | | | | * | *! | | | * |
| c. ɑ d æ m - i - ɣ æ<br>V-Pl V-Pl V-Pl<br>PAL | | | | *! | | | | * | |
| d. ɑ d æ m - i - ʁ ɑ<br>V-Pl V-Pl V-Pl<br>PAL | | | | *! | | | * | | |
| e. ɑ d i m - i - ʁ ɑ<br>V-Pl V-Pl<br>PAL | | | *! | | * | | | | |
| f. æ d i m - i - ɣ æ<br>V-Pl V-Pl<br>PAL | *! | | | | * | | | ** | |

## 6. Conclusions

In sum, representations in which only contrastive features are specified can account for the Uyghur patterns, and do so without requiring the phonological computation to refer to marking statements to determine which features are visible. The representations proposed here account for the transparency of the neutral vowels and for the asymmetry between front and back harmonic vowels. Operating on these representations, the phonological computation can account for the root–suffix asymmetry either through root faithfulness, as shown here, or through cyclic rule application, as in Vaux's (2000) account.

Furthermore, Vaux's analysis of disharmonic roots weakens Halle, Vaux, and Wolfe's (2000) prediction "that there is no language that is exactly like Uyghur, save that the output of raising a disharmonic suffix remains disharmonic." While the subtractive approach to feature specification can generate such a pattern, the same effect could also be derived by ordering ordering post-cyclic vowel harmony before raising in Vaux's framework.

Further patterns in Uyghur are beyond the scope of this paper, but clearly relevant to the analysis of harmony. These include umlaut of /æ/ and /ɑ/ to [e], triggered by a following [i] (including epenthetic [i] but not [i] derived by raising), and vowel–consonant interactions in which dorsal consonants are either velar or uvular, depending in part on the frontness or backness of adjacent vowels. While we do not have the space to explore these patterns here, we believe that our system of representations provides a solid basis for investigating them, as well as an elegant account of the harmony patterns dealt with in this paper.

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