

## ARTICLE

# Uyghur “Umlaut” as Vowel Reduction

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## Abstract

Uyghur (Turkic) exhibits a pattern termed umlaut, which involves raising of low vowels in initial, open syllables to a mid front vowel. This is claimed to be similar to umlaut in Germanic and metaphony in Romance. In this paper, I demonstrate that the Uyghur pattern is not assimilation or positional overwrite, distinguishing it from true umlaut/metaphony patterns. Instead, Uyghur “umlaut” is in fact moderate vowel reduction in a prominent syllable. The proposed analysis derives umlaut from the same forces motivating vowel reduction elsewhere in the language; the differences between the two reduction processes are the result of positional licensing, which determines the general distribution of mid vowels in the language.

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## 1. Introduction

Umlaut and metaphony have received significant attention in the literature dedicated to Germanic and Romance languages, as well as the vowel harmony literature (e.g., Maiden 1991; Wiese 1996; Calabrese 1998, 2011; Walker 2005; Savoia & Maiden 2006 among many others).

Umlaut and metaphony are descriptive terms that generally refer to vowel harmony patterns targeting a prominent (usually stressed) syllable. In addition, these patterns do not spread beyond the prominent syllable and are typically regressive (see Kaplan 2015; Mascaró 2024 for other related patterns). For a given language, I will use the term usually associated with it, but I take both these terms to refer to the same class of phonological processes.

Umlaut in Old High German shares the formal properties of umlaut/metaphony discussed so far. This pattern is regressive, assimilatory, and targets an adjacent stressed syllable only. In particular, the back vowel /a/ fronts to [e] when in stressed position and followed by a high front vowel or glide. Some examples are shown in (1).

- (1) Old High German Umlaut (Ellis 1966: 10)

| No Umlaut       | Umlaut           |                  |
|-----------------|------------------|------------------|
| 'f <u>a</u> ran | 'f <u>e</u> rit  | 'go'/'goes'      |
| 'k <u>a</u> lb  | 'k <u>e</u> lbir | 'calf'/'calves'  |
| 'g <u>a</u> st  | 'g <u>e</u> sti  | 'guest'/'guests' |
| 'l <u>a</u> ng  | 'l <u>e</u> ngi: | 'long'/'length'  |

Though this pattern shows assimilation in frontness, other umlaut/metaphony patterns assimilate for height features. In particular, Italo-Romance varieties are noted for metaphonic height alternations. The dialect of Ascrea exhibits the raising of high-mid vowels in stressed syllables followed by a high vowel, shown in (2). Besides the fact that this pattern is regressive, assimilatory, and targets an adjacent stressed syllable, it clearly shows that the harmony does not extend past the target (Fanti 1938–1940; Maiden 1991; Walker 2005).

- (2) Metaphony in the dialect of Ascrea (Fanti 1938–1940 cited in Maiden 1991, Walker 2005)

| No Metaphony       | Metaphony          |   |
|--------------------|--------------------|---|
| me't <u>e</u> sse  | me't <u>i</u> ʃʃi  | 'reap' 1sg impf. subj./2sg. impf. subj. |
| pre'f <u>o</u> нна | pre'f <u>u</u> nnu | 'profound' f sg/m sg                    |

In this particular example, the target and trigger are both high. However, metaphony can involve strictly partial assimilation. For example, in the same environment the low-mid vowels (/ɛ ɔ/) undergo raising to high-mid vowels rather than high vowels, as seen in (3).

- (3) Partial assimilation in the dialect of Ascrea (Fanti 1938–1940 cited in Maiden 1991, Walker 2005)

| No Metaphony | Metaphony |                               |
|--------------|-----------|-------------------------------|
| 'mɛto        | 'mɛtu     | 'reap' 1sg/3pl pres. ind.     |
| ka'pɔto      | ka'pɔti   | 'overturn' 1sg/2sg pres. ind. |

Umlaut/metaphony patterns are not limited to Germanic and Romance, however. Unrelated languages such as the Australian Aboriginal languages Djingili, Nyangumarda, and Warlpiri (van der Hulst & Smith 1985) and the Indo-Aryan language Sinhala (Fenger & Weisser 2022) also exhibit umlaut. The focus of this paper is the umlaut process reported in Standard Uyghur (Nadzhip 1971; Hahn 1991; Comrie 1997; Mayer *et al.* 2022).

Standard Uyghur (henceforth: Uyghur) umlaut involves the change of the low vowels /æ a/ to [e] in initial, open syllables, as seen in (4). Traditionally, descriptive work argues that umlaut is triggered by [i] in the following syllable and may be triggered by underlying (4a,b; Mayer *et al.* 2022) as well as epenthetic vowels (4c,d; Nadzhip 1971; Hahn 1991; Yakub 2009; Engesæth *et al.* 2009; Abdurehim 2014).

- (4) a. /tæ̃n-i/ [tẽ.ni] body-3.POSS  
 b. /bɑ̃j-i/ [bẽ.ji] head-3.POSS  
 c. /bɑ̃r-f/ [bẽ.ri]f] go-GER  
 d. /kæ̃s-f/ [kẽ.si]f] cut-GER

Thus, given the characteristics it shares with other umlaut patterns – partial regressive harmony targeting an adjacent prominent syllable – umlaut appears to be a natural label for this Uyghur raising process. However, further examination of the Uyghur data calls this into question. The central claim of this paper is that Uyghur “umlaut” actually is not the same type of pattern found in Germanic and Romance. Instead, the Uyghur pattern is better analysed as vowel reduction (Crosswhite 2004).

The paper is structured as follows. Section 2 provides background on Uyghur phonology, presenting the umlaut and vowel reduction patterns in the language. Section 3 presents an analysis of Uyghur umlaut couched in Optimality Theory. Section 4 discusses several alternatives, drawing on other data in the language to further support the proposed analysis. Finally, Section 5 concludes the paper.

## 2. Uyghur umlaut and vowel raising

### 2.1. Background

Uyghur (southeastern Turkic) is spoken by approximately 10 million people, mostly in the People's Republic of China, but there are also significant speaker populations in the Central Asian countries of Kazakhstan, Kyrgyzstan, and Uzbekistan, with smaller diaspora populations in Mongolia, Pakistan, Saudi Arabia, and Turkey (Yakup 2022).

Uyghur has an 8-vowel inventory, as shown in Table 1. The vowels are describable in terms of four features: [high], [low], [back], and [round]. The mid vowels are limited to initial syllables in native and nativised words<sup>1</sup> (Nadzhip 1971; McCollum 2020).

|      | Front     |          | Back      |          |
|------|-----------|----------|-----------|----------|
|      | Unrounded | Rounded  | Unrounded | Rounded  |
| High | i         | <u>y</u> |           | <u>u</u> |
| Mid  | e         | <u>ø</u> |           | <u>o</u> |
| Low  | <u>æ</u>  |          | <u>ɑ</u>  |          |

**Table 1** Uyghur Vowel Inventory, underlined vowels are active in harmony (Mayer *et al.* 2022)

Uyghur exhibits backness harmony, wherein the backness of vowels and dorsal consonants depends on the backness of the preceding vowel. In addition to the alternation of the suffix-initial consonant in (5), these examples also show the effect of harmony on dorsals within roots. Velars co-occur with front vowels; uvulars co-occur with back vowels (Mayer *et al.* 2022; Yakup 2022).

- (5) a. /qol-ɢɑ/ [qol.ɢɑ] hand-DAT  
 b. /køl-ɢɑ/ [køɭ.gæ] lake-DAT

In the general case, the quality of the vowel determines the quality of the consonant. However, two vowels /i e/ do not actively participate in harmony (cf. McCollum 2021). When these neutral vowels occur in a root, the backness of following syllables is unpredictable (Lindblad 1990; Mayer & Major 2021), as is evident in (6a-d). However, in some cases, the place feature of the dorsal consonant can, in fact, condition the backness of the following vowel (6e,f).

- (6) a. /bil-mɑq/ [bil.mæk] know-INF  
 b. /il-mɑq/ [il.mɑq] hang-INF  
 c. /itʃ-lɑr/ [itʃ.lær] interior-PL  
 d. /iʃ-lɑr/ [iʃ.lɑr] work-PL  
 e. /gezit-ɢɑ/ [ge.zit.kæ] newspaper-DAT  
 f. /qisim-ɢɑ/ [qi.sim.ɢɑ] part-DAT

<sup>1</sup>The non-harmonising suffix /-ɣor/ 'eater', from Persian /xordan/ 'to eat', is the only non-derived exception. There are also certain suffixes, diachronically formed from multiword converbial expressions, that can exhibit word-medial umlaut (Mayer *et al.* 2022).

Before describing umlaut, it is worth mentioning stress placement in Uyghur. Though descriptions of stress placement vary substantially (see Yakup 2013; Yakup & Sereno 2016; Major & Mayer 2018 for discussions of acoustic correlates of stress and the relation between stress and pitch), Uyghur stress is often described as word-final (Nadzhip 1971; Hahn 1991, 1998; Schwarz 1992; Comrie 1997; McCollum 2020). Alternatively, some authors have proposed that Uyghur and the larger Turkic family exhibit both initial and final stress (Johanson 2022: 30; Yakup 2005: 65). The present analysis is most compatible with final stress for reasons that I will return to later.

## 2.2. Uyghur umlaut

The basic umlaut data introduced in (4) and repeated in (7a–d) is that the low vowels /æ a/ in initial, open syllables raise to [e]. Several things are noteworthy here. First, umlaut applies regardless of whether the following vowel is underlying (7a,b) or epenthetic (7c,d). Second, umlaut is blocked when the initial syllable is closed (7e,f; Mayer *et al.* 2022).

- |     |              |                       |             |
|-----|--------------|-----------------------|-------------|
| (7) | a. /tæ̃n-i/  | [t <sub>e</sub> .ni]  | body-3.POSS |
|     | b. /bɑ̃[-i/  | [b <sub>e</sub> .fi]  | head-3.POSS |
|     | c. /bɑ̃r-f/  | [b <sub>e</sub> .rif] | go-GER      |
|     | d. /kæ̃s-f/  | [k <sub>e</sub> .si]  | cut-GER     |
|     | e. /bɑ̃r-di/ | [bɑ̃r.di]             | go-3SG.PST  |
|     | f. /kæ̃s-ti/ | [kæ̃s.ti]             | cut-3SG.PST |

In addition to applying across morpheme boundaries, umlaut also applies root-internally. Compare in (8) the Uyghur words for “fish” and “green” to their counterparts in closely related Uzbek, Kazakh, and Kyrgyz (Öztopçu *et al.* 2016).

- |     |               |              |               |               |       |
|-----|---------------|--------------|---------------|---------------|-------|
| (8) | <b>Uyghur</b> | <b>Uzbek</b> | <b>Kazakh</b> | <b>Kyrgyz</b> | Gloss |
|     | [jɛfɪl]       | [jɑfɪl]      | [ʒɑsɯl]       | [dʒɑsɯl]      | green |
|     | [beliɢ]       | [baliɢ]      | [balɯɢ]       | [balɯɢ]       | fish  |

When considering such data, one might question whether umlauted vowels within roots are fossilised remnants of a diachronic change, or if umlaut is synchronically operative within roots, as it is across morpheme boundaries (7). Good evidence for the synchronic reality of umlaut is seen with emphatic reduplication. In Uyghur, the shape of the reduplicant is CVp, copying the initial CV of the root with a following /p/. When the root meaning “green” [jɛfɪl] is reduplicated, the output is [jæp-jɛfɪl] ~ [jɑp-jɛfɪl] (Michael Fiddler, p.c.). Crucially, the reduplicated vowel is [+low], in contrast to the root-internal mid vowel, supporting the activity of umlaut even in non-alternating disyllabic roots.

Further support for the activity of umlaut within roots is found in roots like /ɑ̃ʁz/ ‘mouth’ (Engesæth *et al.* 2009). In the absence of a vowel-initial suffix, an epenthetic vowel is inserted between the root-final consonant cluster (9a,b). The epenthetic vowel in (9a,b) triggers umlaut across a single consonant while umlaut is blocked by the coda consonant in (9c), allowing the underlying low vowel to surface. In sum, the data within

roots parallels the across-morpheme pattern in (7) – umlaut is triggered by underlying (8) as well as epenthetic high vowels (9).

- (9)
- |    |            |             |              |
|----|------------|-------------|--------------|
| a. | /ɑ̣ʁz/     | [e.ʁiz]     | mouth        |
| b. | /ɑ̣ʁz-lar/ | [e.ʁiz.lar] | mouth-PL     |
| c. | /ɑ̣ʁz-i/   | [ɑ̣ʁ.zi]    | mouth-3.POSS |

However, a reviewer notes that in some roots (/æqil/ ‘intelligence’; /kæsip/ ‘major’) umlaut does not occur when expected. Given this, I assume the analysis presented in this paper holds for derived environments and that umlaut holds in a weaker way in the lexicon. This is analogous to backness harmony in Uyghur, which displays the same asymmetry with regard to derived environments and the lexicon.

Based on the evidence presented so far, the Uyghur pattern appears similar to both the raising in the Italo-Romance varieties and fronting in Old High German. Given that the low vowels alternate for both height and frontness, one could plausibly characterise the pattern as either assimilatory fronting or raising (Poppe 1965: 182; Nadzhip 1971: 53–55; Comrie 1981: 65; Yakup 2005, 2009).

Yakup (2005: 63–64) and Abdurehim (2014: 82) marshal several pieces of evidence demonstrating that the pattern cannot be assimilatory fronting. First, as seen in (10), mid round vowels also undergo umlaut in the Turfan and Lopnor dialects. Most significantly, the back round vowels do not front when followed by [i]; instead, they raise (10a,b).

- (10)
- |    |             |             |                 |
|----|-------------|-------------|-----------------|
| a. | /j̥o̞l-i/   | [j̥u.li]    | road-3.POSS     |
| b. | /q̥o̞l-ɨiz/ | [qu.li.ɨiz] | hand-2FRML.POSS |
| c. | /øz-i/      | [y.zi]      | self-3.POSS     |

Second, in some instances, umlaut exceptionally raises underlying /ɑ/ to [o] rather than [e]. One exceptional morpheme reported to induce this behaviour is the deverbal adjective-forming suffix (11). These data further support the case that Uyghur umlaut primarily involves raising rather than fronting (Yakup 2005, 2009).

- (11)
- |    |            |          |           |
|----|------------|----------|-----------|
| a. | /ɑ̣tʃ-uq/  | [o.tʃuq] | open-ADJ  |
| b. | /j̥ɑ̣r-uq/ | [jo.ruq] | split-ADJ |

Furthermore, if umlaut involved the spreading of [-back], then one might expect it to parallel backness harmony in many ways. However, there are key differences between the two. First, dorsal consonants are completely neutral to umlaut (9) though they alternate for backness harmony (5) and also trigger harmony in the absence of a non-neutral vowel (6). An account of umlaut involving spreading of a [-back] feature, would predict (9a) to surface with a front/velar consonant \*[e.giz] rather than a back/uvular consonant, contrary to fact. Second, coda consonants block umlaut (7e,f) but coda consonants do not play any role in backness harmony (5). Finally, a reviewer notes that a few observations about Uyghur backness harmony are suggestive that umlaut does not result from backness harmony. Umlaut involves underlying back vowels being realised as front, but never the other way around. The Uyghur harmony system does not have

such an asymmetry. Moreover, [+back] seems to be the default class in Uyghur, so if an asymmetry in backness harmony were to exist, it is expected that this would favour front vowels becoming back rather than the other way around. Taken together, these facts suggest that umlaut is fundamentally distinct from backness harmony in the language. As such, I conclude any assimilatory account of Uyghur umlaut must treat the pattern as assimilation for height, with ancillary backness alternations emerging from other factors in the language (Johanson 1991: 85–86).

If umlaut is a vowel height alternation, then the similarities between Uyghur and Italo-Romance metaphonies appear even clearer (see Anderson 1974: 62–64; Lindblad 1990: 7–10; Vaux 2023 for other height-based analyses). The low vowels /æ a/ appear to partially assimilate in height to a following [i], similar to low-mid vowels in the dialect of Ascrea (3). Additionally, like many metaphony patterns, only a specific syllable – in this case, the initial syllable – is targeted. Finally, umlaut is triggered locally<sup>2</sup>; [i] does not trigger raising of initial low vowels across intervening syllables (12). There is thus no non-local assimilation across a blocking vowel (cf. Neapolitan and Lena Asturian, Calabrese 2011: 26).

(12) /bɑr-ɑm-siz/ [bɑ̄.rɑm.siz] GO-NONPAST.Q-2SG.FRML

While there are many similarities between the Uyghur pattern and oft-discussed cases of umlaut/metaphony in Indo-European, the Uyghur pattern is not assimilatory in nature. Several pieces of evidence argue against an assimilation analysis. First, umlaut-as-assimilation analyses claim that [i] triggers fronting and raising of the low vowels, in effect making them more [i]-like. Problematically, /i/ in Uyghur is not typically very peripheral and is subject to variability (Mayer & Major 2021). As noted in Hahn (1991), /i/ ranges phonetically from [i] to [ɣ]. McCollum (2020: 18) notes central and back variants of this vowel are far more common and more widely distributed than [i]. This issue is evident in a form like /bɑ̄f-m/ [bɛ̄fɪm] 'head-1SG.POSS.' A more accurate phonetic transcription would be [bɛ̄fɪ̄m]. In this word, umlaut may output a higher front vowel than the second-syllable “trigger”, which is phonetically mid and central. All else being equal, an assimilatory account must make additional stipulations to account for the fact that initial syllables are fronted and raised even though the purported trigger isn't actually front or high. To be clear, by itself this isn't conclusive evidence against umlaut-as-assimilation. There are many metaphonic patterns with triggering vowels that aren't phonetically consistent with the phonological feature they share, as in Castro dei Volsci (Mascaró 2024), where some surface [ə] are suggested to behave as though they are phonologically high.<sup>3</sup>

The key piece of evidence undermining any assimilation-based analysis of Uyghur is the behaviour of non-initial [ǣ]. Umlaut may occur when [ǣ] follows an initial-syllable /ǣ/; in this context “umlaut” is clearly not assimilation (Mayer *et al.* 2022: 15). Observe in (13) that harmony without any interference from umlaut would produce two

<sup>2</sup>A reviewer points out that while many metaphony patterns are strictly local, some, such as Eastern Andalusian (Jiménez & Lloret 2020), are not. While Eastern Andalusian indicates that syllable adjacency of the target and trigger is not a requirement for metaphony, it is still the case that the locality of Uyghur umlaut makes it appear similar to many umlaut/metaphony patterns.

<sup>3</sup>However, see Russo (2007) and references therein for a discussion of centralization in a wider range of dialects and the questions it poses for a synchronic analysis involving high triggers.

identical surface [æ] vowels. However, umlaut outputs initial-syllable [e], resulting in dissimilation of two vowels that would otherwise be identical.

- |      |                             |                       |                        |
|------|-----------------------------|-----------------------|------------------------|
| (13) | a. /k <u>æ</u> l-ɑj/        | [k <u>e</u> .læj]     | come-1SG.OPT           |
|      | b. /j <u>æ</u> -mɑq/        | [j <u>e</u> .mæk]     | eat-INF                |
|      | c. /b <u>æ</u> r-ɑm-siz/    | [b <u>e</u> .ræm.siz] | give-NONPAST.Q-2SG.FML |
|      | d. / <u>æ</u> k <u>æ</u> r/ | [ <u>e</u> .kær]      | sugar                  |

These data crucially undermine any assimilation account of Uyghur umlaut. Harmony produces two identical vowels without umlaut. However, umlaut results in two vowels that disagree for the feature [low]. No account of Uyghur umlaut as assimilation will be able to capture these facts.

If “umlaut” isn’t assimilation, what is it? In the following subsection I compare umlaut to another process in Uyghur termed “vowel raising” (Mayer *et al.* 2022), arguing that both are forms of vowel reduction.

### 2.3. Uyghur vowel raising

Uyghur exhibits a pattern of vowel reduction sometimes called vowel raising in the descriptive literature. In this pattern, low vowels /æ ɑ/ raise to [i] in word-medial open syllables (Nadzhip 1971; Hahn 1991; Mayer *et al.* 2022), as seen in (14).

- |      |                                   |               |                    |
|------|-----------------------------------|---------------|--------------------|
| (14) | a. /ba <u>l</u> ɑ-l <u>ɑ</u> r-i/ | [ba.li.li.ri] | child-PL-3.POSS    |
|      | b. /tik <u>æ</u> -dɑ/             | [ti.ki.dæ]    | billy.goat-LOC     |
|      | c. /søz-l <u>æ</u> -di/           | [søz.li.di]   | word-VBLZR-3SG.PST |
|      | d. /ɑp <u>ɑ</u> -si/              | [ɑ.pi.si]     | mother-3.POSS      |

Like umlaut, raising does not occur in closed syllables (15).

- |      |                         |                      |                         |
|------|-------------------------|----------------------|-------------------------|
| (15) | a. /ba <u>l</u> ɑ-m-dɑ/ | [ba.lɑm.dɑ]          | child-1SG.POSS-LOC      |
|      | b. /tik <u>æ</u> -m-dɑ/ | [ti.k <u>æ</u> m.dæ] | billy.goat-1SG.POSS-LOC |

There is an interesting interaction between umlaut and raising in Uyghur. Umlaut occurs before underlying and epenthetic [i] (7a-d; 16a; Hahn 1991: 52), but umlaut does not occur before [i] derived from vowel raising (16b).

- |      |                        |                      |            |
|------|------------------------|----------------------|------------|
| (16) | a. /b <u>ɑ</u> r-f-qɑ/ | [b <u>e</u> .ri].qɑ] | go-GER-DAT |
|      | b. /b <u>ɑ</u> lɑ-lɑr/ | [b <u>ɑ</u> .li.lɑr] | child-PL   |

This presents another challenge for the view that umlaut is regressive assimilation. If [i] triggers umlaut, then why does raised [i] behave differently than epenthetic and underlying [i]? The only discussion of this interaction is found in Vaux (2023), though Vaux’s rule-based analysis is concerned only with describing the pattern, and does not attempt to explain the different behaviour of these surface vowels.

## 2.4. Umlaut and vowel raising compared

Umlaut and vowel raising overlap in several interesting ways. Both processes affect low vowels /æ a/ in open syllables (17) but not in closed syllables (18).

- (17) **Umlaut:** /kæl-ɑj/ [ke.læj]  
               /ɓɑr-ɟ/ [be.riɟ]
- Raising:** /tikæ-da/ [ti.ki.dæ]  
               /ɓɑɑ-lar/ [bɑ.li.lɑr]
- (18) **No Umlaut:** /kæl-di/ [kæl.di]  
               /ɓɑr-di/ [ɓɑr.di]
- No Raising:** /tikæ-m-da/ [ti.kæm.dæ]  
               /ɓɑɑ-m-da/ [bɑ.lɑm.dɑ]

The output of both processes is a non-low front vowel. Additionally, the processes apply in a type of complementary distribution – umlaut only occurs in initial syllables, while vowel raising only occurs in word-medial syllables. Neither occur in word-final syllables.<sup>4</sup> Despite these similarities, Uyghur umlaut and vowel raising have been analysed separately and claimed to be independent processes in previous work (though see the description in Engesæth *et al.* 2009 where both processes fall under the umbrella term ‘A-raising’).

The apparent differences between the two processes can be summarised as follows:

- i. The output of umlaut and vowel reduction disagree for the feature [high].
- ii. Umlaut applies in initial syllables only, and vowel raising applies in medial syllables only.
- iii. Umlaut requires [i] or [æ] in the following syllable, but vowel raising applies in any open medial syllable.

However, when considering other facts about the phonology of Uyghur, these differences largely disappear. Regarding differences i. and ii., recall the vowel inventory of Uyghur in Table 1. Of the 8 vowels in Uyghur, only /e/ and /i/ are not active in vowel harmony, forming a natural class. Second, [i] occurs as an allophone of /e/ in Standard Uyghur (Mayer *et al.* 2022). Additionally, there is microvariation with respect to umlaut across Uyghur dialects; in the Lopnor (19a) and Turfan (19b) dialects, umlaut may output [i], as well as [e] (19).

- (19) a. /kæs-p/ [ki.sip] cut-cvB (Abdurehim 2014)  
       b. /ɓɑɟ-i/ [bi.ɟi] head-3.POSS (Yakup 2005)

Concerning (ii), mid vowels are permitted in initial syllables only (Nadzhip 1971; McCollum 2020). Thus, one could reasonably claim that raising would yield [e] if mid

<sup>4</sup>However, see Hahn (1991: 53) for examples of word-final vowel reduction in phrase-medial position.

vowels were permitted in non-initial syllables. In fact, early textual examples of raising report [e] rather than [i] in some instances, e.g., [bale-si] 'child-3.POSS' (Yakup 2005: 18). As such, differences (i) and (ii) do not stem from fundamental differences in umlaut and vowel reduction – the difference in outputs and domain of application is derived from the restriction on mid vowels that bans them in non-initial syllables.

Then, only difference (iii) remains. Why do only [i æ] trigger umlaut? Since [e ø o] are banned in non-initial syllables, only five vowels may possibly trigger umlaut, [i y æ u α]. Mayer *et al.* (2022) demonstrate that both [i æ] trigger umlaut while [α] does not. No previous work describes the behaviour of [y u] with regard to umlaut. It is uncommon for rounded vowels to follow unrounded ones in Uyghur, and both the low vowels are unrounded. However, there is evidence that these vowels can trigger umlaut in the Turfan dialect. The texts in Yakup (2005) indicate that both the [+high, +round] vowels may also trigger umlaut (20). One difference between the Turfan dialect and Standard Uyghur is the degree of raising – umlaut produces high vowels in Turfan while it produces mid vowels in Standard Uyghur. Observe that underlying [+round] vowels (20a), epenthetic vowels that undergo rounding harmony (20b), and underlying [-round] vowels that undergo rounding harmony (20c) all may trigger umlaut of a preceding low vowel.<sup>5</sup>

- (20) a. /dæ-βu-dæk/ [di.gy.dæk] say-GER-PART (Yakup 2005: 286, 308)  
 b. /qol-ŋ-dm/ [qu.luŋ.din] hand-2.POSS-ABL (Yakup 2005: 226)  
 c. /qol-i-βα/ [qu.lu.βα] hand-3.POSS-DAT (Yakup 2005: 292)

A reviewer checked with an Uyghur consultant and found that umlaut also occurs before [y] in Standard Uyghur (21a), and found another example (21b) which supports this finding.

- (21) a. /jæ-βu/ [je.gy] eat-GER  
 b. /jæ-βu-i/ [je.gy.si] eat-GER-3.POSS (Gabre & Gaines 2017: 71)

This indicates that umlaut is a general raising process in initial syllables, and there is only an interaction with the following syllable when the vowel is [α]. Then, deviating from the standard view where [i] or [i æ] serve as triggers for umlaut (Mayer *et al.* 2022), the question is: why doesn't [α] trigger umlaut? As seen in (22), /α...α/ sequences surface faithfully.

- (22) /qα-αj/ [qα.lαj] stay-1SG.OPT

To preview the analysis to follow, umlaut is blocked in /α...α/ sequences precisely because it would result in disharmony – \*[e...α] would violate backness harmony. In Section 3 I argue that in addition to the general backness harmony in the language, there is parasitic harmony dependent on height that blocks umlaut in these instances. As a result, difference (iii) effectively disappears. Umlaut is constrained by harmony, but is not reducible to harmony or feature-spreading more generally.

<sup>5</sup>Rounding harmony in Uyghur is optional in certain contexts (Hahn 1991; McCollum 2019). Note that Yakup's examples cited in (10) do not exhibit harmony, but the examples from his texts in (20) do.

## 2.5. Two degrees of vowel reduction

Vowel reduction refers to the neutralization of vowels in unstressed syllables (Trubetzkoy 1969; Crosswhite 2004; Harris 2005). Crosswhite (2004) notes that certain languages exhibit two degrees of vowel reduction, an extreme form in most unstressed syllables and a moderate form in more prominent syllables. She provides examples from Southern Russian, Contemporary Standard Russian, Rhodope Bulgarian, dialects of Italy, and Standard Brazilian Portuguese to support these claims. I will focus on the Contemporary Standard Russian (henceforth: Russian) pattern. In Russian, /a/ and /o/ are neutralised in unstressed syllables.

|      |     |             |               |                 |
|------|-----|-------------|---------------|-----------------|
| (23) | /a/ | /skazka/    | ['skaskə]     | 'fairy tale'    |
|      |     | /zəc:ititʲ/ | [zəc:ɪ'tʲitʲ] | 'to defend'     |
|      | /o/ | /kosmos/    | ['kosməs]     | 'space, cosmos' |
|      |     | /pobeditʲ/  | [pəbʲɪ'dʲitʲ] | 'to win'        |

In (23), /a/ and /o/ neutralise to [ə] in unstressed syllables. However, (24) shows that in the immediately pretonic syllable these vowels neutralise to [ɐ] (Barnes 2007).

|      |               |             |             |
|------|---------------|-------------|-------------|
| (24) | a. /napadatʲ/ | [nəpɐ'datʲ] | 'to attack' |
|      | b. /golodatʲ/ | [gələdatʲ]  | 'to starve' |

This more moderate reduction is attributed to the increased duration of the immediately pretonic syllable relative to other unstressed syllables in Russian (Crosswhite 2004; Barnes 2006). The Uyghur and Russian data then provide a nice comparison (25).

|      |                           |               |                |
|------|---------------------------|---------------|----------------|
| (25) |                           | <b>Uyghur</b> | <b>Russian</b> |
|      |                           | /æ a/         | /a o/          |
|      | <b>Moderate Reduction</b> | e             | ɐ              |
|      | <b>Extreme Reduction</b>  | i             | ə              |

Uyghur umlaut only occurs in initial syllables, which are cross-linguistically shown to exhibit strength effects (Steriade 1994; Zoll 1996, 2008; Beckman 1997, 1998). In Uyghur, initial syllables may license all eight vowel contrasts as well as all syllable shapes, and also typically control vowel harmony. Moreover, some research on Uyghur and Turkic more broadly argues that initial syllables in Turkic are prosodically prominent (Hahn 1998; Yakup 2005; Johanson 2022). Thus, the next section will show that umlaut and raising differ only in the degree of resistance exerted by positional prominence – reduction of initial syllables is mitigated by positional licensing; medial syllables exhibit no such prominence and are fully reduced to [i].

## 3. Formal analysis

This section gives an account of Uyghur vowel reduction including umlaut as moderate reduction in Optimality Theory (OT; Prince & Smolensky 2004). I first discuss stress

and sonority in Uyghur. Then I present an account of vowel reduction, and extend this account to account for umlaut.

### 3.1. Uyghur stress in Optimality Theory

As noted in Section 2.1, I am assuming Uyghur exhibits word-final stress, though in principle this analysis is compatible with other analyses. McCollum (2020) argues on the basis of a production experiment that Uyghur has sonority-driven stress with sonority encoded as moraic weight. McCollum's arguments for these claims are based on final lengthening and compensatory lengthening. McCollum notes that high vowels are lengthened in word-final (and therefore stressed) open syllables. He argues this is phonological and not phonetic based on an asymmetry in the lengthening of high and low vowels, as well as the fact that consonants do not undergo final lengthening. Taking this final lengthening to be phonological, the fact that high vowels undergo a significantly higher degree of final lengthening requires an explanation. He proposes that stressed syllables must be heavy, and that due to their higher sonority low vowels are bimoraic while high vowels, which are less sonorous, are monomoraic. Low vowels are intrinsically heavy and may occur in stressed open syllables. However, high vowels are too light to occur in stressed open syllables unless they undergo final lengthening, which introduces an extra mora. McCollum also claims that coda consonants are moraic since final lengthening does not occur in closed syllables. Further evidence for this comes from compensatory lengthening. In Uyghur, coda /r/, e.g., in the plural suffix /-lar/, is often deleted, and vowels in syllables with deleted /r/ undergo compensatory lengthening (Nadzhip 1971; Hahn 1991; McCollum 2020).

McCollum formalises his analysis of Uyghur stress in OT. The rankings ALLFEET-R  $\gg$  PARSE- $\sigma$  and IAMB  $\gg$  TROCHEE ensure word-final stress assignment. The constraints in (26) account for the lengthening of word-final high vowels.

- (26)
- a. WEIGHT-TO-STRESS (W2S): assign a violation to every stressed syllable that is monomoraic
  - b. WEIGHT-BY-POSITION (WBP): assign a violation to every coda consonant that does not project a mora
  - c. \*HEAVY: assign a violation to every syllable that has more than one mora
  - d. ID-IO<sub>[HI]</sub>: assign a violation to every input-output vowel pair that disagree for the feature [high]
  - e. \*2 $\mu$ <sub>[-LO]</sub>: assign a violation to every bimoraic surface vowel that is [-low]
  - f. \* $\mu$ <sub>[+LO]</sub>: assign a violation to every monomoraic surface vowel that is [+low]

The ranking W2S  $\gg$  \*HEAVY allows for a heavy syllable in stressed position, and the ranking ID-IO<sub>[HI]</sub>  $\gg$  \*2 $\mu$ <sub>[-LO]</sub> ensures that word-final high vowels are lengthened rather than lowered in final position to meet the WEIGHT-TO-STRESS requirement (27). In general, \*2 $\mu$ <sub>[-LO]</sub> and \* $\mu$ <sub>[+LO]</sub> ensure that surface vowels adhere to the observed moraic

requirements in Uyghur without having to make stipulations on inputs that would violate Richness of the Base. As seen in (28), this constraint ranking also correctly predicts that final high vowels are not lengthened in closed syllables.

|      | /kiʃi/                                | WBP | W2S | *HEAVY | ID-IO <sub>[HI]</sub> | *2 <sub>μ</sub> [-LO] |
|------|---------------------------------------|-----|-----|--------|-----------------------|-----------------------|
| (27) | a. ki <sub>μ</sub> .ʃi <sub>μ</sub>   |     | *!  |        |                       |                       |
|      | b. ki <sub>μ</sub> .ʃæ <sub>μμ</sub>  |     |     | *      | *!                    |                       |
|      | c. ki <sub>μ</sub> .ʃi: <sub>μμ</sub> |     |     | *      |                       | *                     |

|      | /kiʃim/  | WBP | W2S | *HEAVY | *2 <sub>μ</sub> [-LO] |
|------|--|-----|-----|--------|-----------------------|
| (28) | a. ki <sub>μ</sub> .ʃi <sub>μ</sub> m <sub>μ</sub>   |     |     | *      |                       |
|      | b. ki <sub>μ</sub> .ʃi: <sub>μμ</sub> m <sub>μ</sub> |     |     | *      | *!                    |
|      | c. ki <sub>μ</sub> .ʃi: <sub>μμ</sub> m              | *!  |     | *      | *                     |

### 3.2. Uyghur vowel reduction as mora reduction in OT

McCullum (2020) also shows that his proposed constraints and constraint rankings account for vowel raising as mora reduction. For example, given a highly ranked MAX-C, McCullum correctly predicts raising of low vowels in word-medial open syllables (29) but no raising in word-medial closed syllables (30).

|      | /tikæ-dɑ/   | MAX-C | * <sub>μ</sub> [+LO] | *HEAVY | ID-IO <sub>[HI]</sub> |
|------|---|-------|----------------------|--------|-----------------------|
| (29) | a. ti <sub>μ</sub> .kæ <sub>μμ</sub> .ʔdæ <sub>μμ</sub> |       |                      | **!    |                       |
|      | b. ti <sub>μ</sub> .ki <sub>μ</sub> .ʔdæ <sub>μμ</sub>  |       |                      | *      | *                     |
|      | c. ti <sub>μ</sub> .kæ <sub>μ</sub> .ʔdæ <sub>μμ</sub>  |       | *!                   | *      |                       |

|      | /tikæ-m-dɑ/  | MAX-C | * <sub>μ</sub> [+LO] | *HEAVY | ID-IO <sub>[HI]</sub> |
|------|--|-------|----------------------|--------|-----------------------|
| (30) | a. ti <sub>μ</sub> .kæ <sub>μμ</sub> m <sub>μ</sub> .ʔdæ <sub>μμ</sub> |       |                      | **     |                       |
|      | b. ti <sub>μ</sub> .ki <sub>μ</sub> m <sub>μ</sub> .ʔdæ <sub>μμ</sub>  |       |                      | **     | *!                    |
|      | c. ti <sub>μ</sub> .ki <sub>μ</sub> .ʔdæ <sub>μμ</sub>                 | *!    |                      | *      | *                     |
|      | d. ti <sub>μ</sub> .kæ <sub>μ</sub> m <sub>μ</sub> .ʔdæ <sub>μμ</sub>  |       | *!                   | **     |                       |

Reduction occurs in open syllables because low vowels are bimoraic and high vowels are monomoraic, and so raising a low vowel to a high vowel in an open syllable reduces the number of violations of \*HEAVY. The fact that \*HEAVY punishes syllables that are at least bimoraic means it does not distinguish between bimoraic and trimoraic syllables. Thus, although raising a low vowel in a closed syllable reduces the number of moras, it does not reduce the number of violations of \*HEAVY. Since MAX-C ≫ \*HEAVY, reduction in closed syllables is never optimal.

### 3.3. Uyghur umlaut as mora reduction in OT

If umlaut is simply an instance of vowel reduction in Uyghur, then it should be possible to derive “umlaut” from the preference for light vowels in unstressed, open syllables argued for by McCollum (2020). The first claim to be made is that mid vowels are monomoraic. McCollum does not mention mid vowels in his Uyghur analysis since he only examines final syllables, and mid vowels only occur in initial syllables, but this claim finds support in the lack of CV content words containing mid or high vowels.<sup>6</sup> This suggests a bimoraic word minimality requirement with mid and high vowels patterning as lighter than low vowels, and this analysis will assume low vowels are bimoraic and non-low vowels are monomoraic. Meanwhile, length differences such as the final lengthening or compensatory lengthening reported by McCollum (2020) or the underlying long vowels that will be examined in Section 4 will be represented with an extra mora. So, long low vowels are trimoraic and long non-low vowels are bimoraic. The analysis presented here will focus on “canonical” mora counts (2 moras for short low vowels and 1 mora for short non-low vowels), and Section 3.5 will discuss inputs with different mora counts.

To capture the basic cases of umlaut, the distribution of mid vowels needs to be explained. Since mid vowels only occur in initial syllables, I propose a licensing constraint (31) that controls their distribution (Crosswhite 2004).

- (31) LIC-MID/ $\sigma_1$ : assign a violation to every [-high, -low] vowel not in the initial syllable

The ranking LIC-MID/ $\sigma_1$   $\gg$  ID-IO[HI] ensures that mora reduction by raising to a mid vowel can only occur in initial syllables, and is ruled out in medial syllables. Tableau (29) is redone with the licensing constraint as Tableau (32) to demonstrate this.

|      | /tikæ-dɑ/                                 | LIC-MID/ $\sigma_1$ | * $\mu$ [+LO] | *HEAVY | ID-IO[HI] |
|------|---|---------------------|---------------|--------|-----------|
| (32) | a. $t_i\mu.k\ae\mu\mu.^1d\ae\mu\mu$       |                     |               | **!    |           |
|      | b. $t_i\mu.ke\mu.^1d\ae\mu\mu$            | *!                  |               | *      |           |
|      | $\text{☞}$ c. $t_i\mu.ki\mu.^1d\ae\mu\mu$ |                     |               | *      | *         |
|      | d. $t_i\mu.k\ae\mu.^1d\ae\mu\mu$          |                     | *!            | *      |           |

Umlaut of /æ/ before [i], /æ/ before [æ], and /ɑ/ before [i] are shown in (33), (34), and (35) respectively.

|      | /tæ-n-i/                         | LIC-MID/ $\sigma_1$ | *HEAVY | ID-IO[HI] | ID-IO[LO] |
|------|----------------------------------|---------------------|--------|-----------|-----------|
| (33) | a. $t\ae\mu\mu.^1ni\mu\mu$       |                     | **!    |           |           |
|      | $\text{☞}$ b. $te\mu.^1ni\mu\mu$ |                     | *      |           | *         |
|      | c. $t_i\mu.^1ni\mu\mu$           |                     | *      | *!        | *         |

<sup>6</sup>A reviewer mentioned that there are words such as /su/ ‘water’, /po atmaq/ ‘to brag’ and the names for letters e.g., /te/ ‘T’, that are counterexamples to this claim. As far as I am aware, this is not the case. For example, ‘water’ is orthographically represented as a CV word, but there is evidence that the underlying form has a glide in coda position: /suw/. Evidence for this comes from the 3Poss suffix, which surfaces as [-si] after stems ending in vowels and [-i] after stems ending in consonants. I checked with one Uyghur speaker who confirmed the form for *water-3poss* is [suw-i], not \*[su-si]. Meanwhile, a word that ends in /u/ such as /tohu/ ‘chicken’ becomes [tohu-si] (Engesæth *et al.* 2009: 114). This analysis predicts that the mid vowels in ‘to brag’ and ‘T’ either must also be followed by glides or that they surface as long vowels.

|      | /bær-ɑj/   | LIC-MID/ $\sigma_1$ | *HEAVY | ID-IO[HI] | ID-IO[LO] |
|------|--|---------------------|--------|-----------|-----------|
| (34) | a. bæ <sub>μμ</sub> ·'ræ <sub>μμ</sub> j <sub>μ</sub>  |                     | **!    |           |           |
|      | ☞ b. be <sub>μ</sub> ·'ræ <sub>μμ</sub> j <sub>μ</sub> |                     | *      |           | *         |
|      | c. bi <sub>μ</sub> ·'ræ <sub>μμ</sub> j <sub>μ</sub>   |                     | *      | *!        | *         |

|      | /jɑn-i/                                 | LIC-MID/ $\sigma_1$ | *HEAVY | ID-IO[HI] | ID-IO[LO] |
|------|---|---------------------|--------|-----------|-----------|
| (35) | a. jɑ <sub>μμ</sub> ·'ni <sub>μμ</sub>  |                     | **!    |           |           |
|      | ☞ b. je <sub>μ</sub> ·'ni <sub>μμ</sub> |                     | *      |           | *         |
|      | c. ji <sub>μ</sub> ·'ni <sub>μμ</sub>   |                     | *      | *!        | *         |

In all these cases, \*HEAVY motivates the raising of bimoraic low vowels in initial syllables. Meanwhile, since it is the initial syllable, mid vowels are licensed and the faithfulness constraint ID-IO[HI] punishes raising all the way to high vowels. As seen in (36), umlaut, like vowel reduction, does not affect vowels in closed syllables. Since \*HEAVY penalises both bimoraic and trimoraic syllables, \*HEAVY does not distinguish between the first two candidates. So, the faithful candidate is preferred due to the lower ranked faithfulness constraint ID-IO[LO].

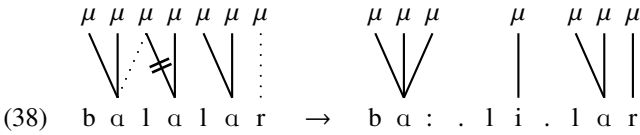
|      | /bær-di/  | MAX-C | *HEAVY | ID-IO[HI] | ID-IO[LO] |
|------|---|-------|--------|-----------|-----------|
| (36) | ☞ a. bæ <sub>μμ</sub> r <sub>μ</sub> ·'di <sub>μμ</sub> |       | **     |           |           |
|      | b. be <sub>μ</sub> r <sub>μ</sub> ·'di <sub>μμ</sub>    |       | **     |           | *!        |
|      | c. be <sub>μ</sub> ·'di <sub>μμ</sub>                   | *!    | *      |           | *         |

### 3.4. No umlaut before raised [i]

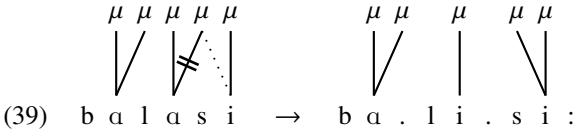
Interestingly, umlaut occurs before epenthetic [i], shown in (37a), but not before [i] derived via vowel raising (37b).

- (37) a. /bar-f/      [be.ri]      go-GER  
 b. /balɑ-lar/    [ba.li.lar]    child-PL

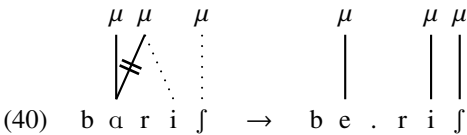
This presents a major challenge for the standard view of umlaut as regressive assimilation, which has to explain why these two instances of surface [i] behave differently with respect to umlaut. In fact, Vaux (2023) has used the apparent counterfeeding relationship between vowel raising and umlaut as part of an argument that constraint based formalisms, even with multiple strata, cannot capture the observed interactions in Uyghur. However, under the present analysis, the introduction of autosegmental representations can explain the asymmetry between epenthetic and underlying [i] and [i] that results from vowel raising. Given this representational system, vowel reduction is mora delinking rather than mora deletion. For example, vowel raising in (37b) is represented in (38).



Vowel raising then consists of one mora delinking from the word-medial low vowel. Assuming a constraint that punishes floating moras, delinked moras must reassociate to an adjacent syllable if possible. This need not be the preceding syllable. The delinked mora in (39) is reused for final lengthening.



Unlike raised vowels, epenthetic vowels can serve as hosts for delinked moras without becoming heavy (40). The OT analysis in (42) will show that it is preferable for an epenthetic vowel to host the delinked mora from the initial syllable rather than to also epenthesise a mora.



To formalise reduction as mora-delinking, the constraints in (41) are needed.

- (41) a. **MAX- $\mu$** : assign a violation for every mora in the input that is deleted in the output  
 b. **DEP- $\mu$** : assign a violation for every mora in the output that is not in the input  
 c. **\*FLOAT**: assign a violation to every mora not associated to a segment in the output  
 d. **\*4 $\mu\sigma$** : assign a violation to every syllable that has 4 or more moras associated with it  
 e. **\*3 $\mu$ [ $\uparrow$ -LO]**: assign a violation to every non-low vowel that has 3 or moras associated with it  
 f. **\*HEAVY/WK**: assign a violation to every weak syllable that has 2 or more moras associated with it

In principle, Uyghur allows CVCC syllables, but as noted in Hahn (1991), final clusters are often repaired by either vowel epenthesis or consonant deletion (e.g., /xæɫq/ → [xæɫiq] ~ [xæq] ‘nation’, but [xæɫq-i] ‘nation-3.POSS’). This avoidance of CVCC is encoded in the analysis by \*4 $\mu\sigma$ . In particular, this analysis predicts that CVCC is more likely to be avoided if the V is [+low], as a [+high] V in CVCC would not violate \*4 $\mu\sigma$ . However, this is an issue left open here for future research. \*4 $\mu\sigma$  also ensures

that low vowels can be at most trimoraic. Meanwhile,  $*3\mu_{[-LO]}$  encodes that non-low vowels can have a maximum of two moras. This difference between low and non-low vowels is consistent with McCollum's data. McCollum shows that both low and non-low vowels can lengthen and take on an extra mora, but since low vowels are presumed to be underlyingly bimoraic and non-low ones to be monomoraic, the maximal number of moras for low vowels is also one mora more than for non-low vowels.

MAX- $\mu$ , like MAX-C, must be ranked above \*HEAVY and \*HEAVY/WK to prevent umlaut and reduction in closed syllables. However, it must be outranked by  $*4\mu/\sigma$  since we never see syllables surfacing with more than 3 moras. \*FLOAT bans floating autosegments (Myers 1997). The final constraint introduced here, \*HEAVY/WK, requires further explanation. I am treating initial and stressed (i.e. final) syllables as strong, and therefore the weak positions are all other (i.e. medial) syllables. All contrastive vowels are licensed in initial syllables and initial-syllable vowels typically determine the backness of following vowels. Similarly, stressed syllables are longer and also resist vowel reduction. Thus, the same sorts of facts that hold in Uyghur have been used to argue for the positional prominence of initial and stressed syllables cross-linguistically (Steriade 1994; Zoll 1996, 2008; Beckman 1997, 1998; Crosswhite 2004; Walker 2005; Kaplan 2015).

Assuming DEP-LINK- $\mu$  is lowly ranked, the constraint ranking in the following tableaux accounts for umlaut before epenthetic vowels (42) as in the standard cases of umlaut, while also accounting for the lack of umlaut before raised vowels (43).

(42) Umlaut before an epenthetic vowel

|   |            |        |           |
|---|------------|--------|-----------|
| $\mu \mu$<br><br>b a r f                      | DEP- $\mu$ | *HEAVY | ID-IO[hi] |
| $\mu \mu \quad \mu \mu$<br><br>a. b a . r i f | **!        | **     |           |
| $\mu \mu \quad \mu$<br><br>b. b e . r i f     | *          | *      |           |
| $\mu \mu \quad \mu$<br><br>c. b i . r i f     |            | *      | *!        |

The epenthetic vowel [i] is not present in the input. Thus, Candidate (42b), which hosts the mora delinked from the initial syllable, is preferable to Candidate (42a), which epenthesises its own mora.

(43) No umlaut before a reduced vowel

|   |                     |           |        |        |           |
|---|---------------------|-----------|--------|--------|-----------|
| $\mu \mu \mu \mu \mu$<br><br>b a l a l a r                                | *4 $\mu$ / $\sigma$ | *HEAVY/WK | *FLOAT | *HEAVY | Id-IO[hi] |
| $\mu \mu \quad \mu \mu \quad \mu \mu \mu$<br><br>a. b a . l a . l a r     |                     | *!        |        | ***    |           |
| $\mu \mu \quad \mu \mu \quad \mu \mu \mu$<br><br>b. b a : . l i . l a r   |                     |           |        | **     | *         |
| $\mu \mu \quad \mu \mu \quad \mu \mu \mu$<br><br>c. b e . l i a : . l a r |                     | *!        |        | **     |           |
| $\mu \mu \quad \mu \mu \quad \mu \mu \mu$<br><br>d. b e . l i . l a r     |                     |           | *!*    | *      | *         |
| $\mu \mu \quad \mu \mu \quad \mu \mu \mu$<br><br>e. b a . l i . l a : r   | *!                  |           |        | **     | *         |

The apparent counterfeeding between vowel reduction and umlaut falls out from the \*HEAVY/WK  $\gg$  \*FLOAT  $\gg$  \*HEAVY ranking. This ranking ensures that umlaut is dependent on a mora both delinking from a vowel in a strong position (to satisfy \*HEAVY) and relinking to another syllable in the output (to satisfy \*FLOAT). Relinking to another syllable is dependent on that syllable being able to host another mora, i.e. it should have at most 2 moras before taking on another one so as not to violate \*4 $\mu$ / $\sigma$ . This prevents umlaut before raised vowels because either the mora delinked from the initial syllable must re-link to the adjacent medial syllable making it heavy (effectively undoing/preventing the effect of raising; or that delinked mora must remain floating (43d)). This also explains why umlaut is impossible in (39) even though the initial vowel does not become long. Yet, while this ranking blocks umlaut before a reduced vowel, it correctly allows for vowel reduction in consecutive syllables since \*HEAVY/WK  $\gg$  \*FLOAT. One empirical prediction of this analysis, that I will leave for future research, is that some words with reduction will have trimoraic vowels adjacent to a reduced syllable that are observably longer in duration than bimoraic vowels in the language e.g., the first syllable in (43b).

The introduction of the autosegmental analysis does not affect the cases of umlaut previously examined in (33)-(35). Umlaut in the word /bæ:r-qj/, first analysed in (34), looks as follows in the current (and final) version of the analysis.

## (44) Umlaut of /æ/ before [æ] (cf. 34)

|                     |                |            |           |        |        |           |
|---------------------|----------------|------------|-----------|--------|--------|-----------|
| <br>b æ r æ j       | $*4\mu/\sigma$ | DEP- $\mu$ | *HEAVY/WK | *FLOAT | *HEAVY | ID-IO[hi] |
| a.<br>b æ . r æ j   |                | *!         |           |        | **     |           |
| <br>b. b e . r æ j  |                |            |           |        | *      |           |
| c.<br>b e . r æ j   |                | *!         |           | *      | *      |           |
| d.<br>b e . r æ : j | *!             | *          |           |        | *      |           |

Essentially, umlaut is dependent on an available host for the mora that delinks from the initial syllable. In (33) and (35) this mora can be hosted by the final vowel, which must gain an extra mora to satisfy W2S anyway. The trickier case is the one shown in (44). The coda consonant in the final syllable requires a mora to satisfy WBP. However, assuming a highly ranked constraint preserving the linear order of the moras in the input, the derivation must be the one shown in (44b). Since DEP-LINK- $\mu$  has already been said to be lowly ranked, the additional reassignment of moras is not significant for determining the optimal candidate. Umlaut before underlying vowels in words that are trisyllabic or longer has a similar pattern of mora delinking and re-linking. An example for /jɑn-i-ʁɑ/ ‘side-3.POSS-DAT’ is given in (45).

$$\begin{array}{c}
 \mu \mu \mu \mu \mu \\
 \begin{array}{c}
 \diagdown \quad \diagup \\
 \diagdown \quad \diagup \\
 \diagdown \quad \diagup \\
 \diagdown \quad \diagup \\
 \diagdown \quad \diagup
 \end{array}
 \end{array}
 \rightarrow
 \begin{array}{c}
 \mu \quad \mu \quad \mu \mu \mu \\
 | \quad | \quad \begin{array}{c} \diagdown \quad \diagup \\ \diagdown \quad \diagup \end{array}
 \end{array}$$

(45) j a n i ʁ a → j e . n i . ʁ a :

Such mora reassignment seems to (incorrectly) predict that with a sufficiently long word (four or more syllables), both umlaut and reduction can occur together. This would involve at least one syllable that surfaces with a maximal number of moras (3 or 2 depending on the vowel height and presence/absence of a coda consonant) but also had a mora delink and relink to another syllable. An example derivation for /bala-lar-da/ child-PL-LOC → \*[be.li.lar.da] is given in (46).



of inputs changes the predicted outputs, this is not an issue with respect to Richness of the Base. In a similar vein, we can consider Uyghur backness harmony. The fact that changing the backness of the input /tikæ/ ‘billy goat’ to /tika/ predicts a different harmony pattern when suffixes are added e.g., \*[tika-m-da] instead of [tikæ-m-dæ] billy.goat-1SG.POSS-LOC, is not an unwelcome result since the language is known to be sensitive to the manipulation of the feature [back].

### 3.6. Parasitic backness harmony

The analysis presented so far can account for every case when umlaut occurs. However, it cannot account for the asymmetry between /æ/ and /ɑ/.<sup>8</sup> Specifically, umlaut is incorrectly predicted to occur in words with /ɑ...ɑ/.

(47) /bɑla/ [bɑ.'la]/\*[bɛ.'la] child

As noted previously, the fact that umlaut fails in (47) while applying with second-syllable [æ], as in (48), motivated Mayer *et al.* (2022) to treat [i] and [æ] as triggers.

(48) /ʃækæɾ/ [ʃɛ.'kæɾ]/\*[ʃæ.'kæɾ] sugar

While an assimilatory account of umlaut with [i] and [æ] as triggers has the numerous problems discussed earlier, (47) is the biggest challenge to an account of umlaut as vowel reduction. If umlaut isn't triggered by any particular vowel, then why does umlaut fail when the second-syllable vowel is [ɑ]? In these instances, the output of umlaut [e...ɑ] would violate backness harmony. Though other instances of reduction, e.g., vowel raising, violate backness harmony, the relevant vowels disagree for [high]. However, in (47) the potential output \*[e...ɑ] are both [-high]. I conclude that the failure of umlaut in these instances derives not from umlaut itself, but rather from parasitic backness harmony. Analysing this as an instance of backness harmony that is parasitic on height agreement can account for the differences between (47) and (48). This parasitic backness harmony must be active in addition to the general backness harmony that is active in the language. Additionally, it indicates that rather than /e/ being neutral to harmony as previously stated, it is a limited participant. Parasitic harmony applies only when trigger and target agree for some other feature (Cole & Trigo 1988). Rounding harmony in Yowlumne (also known in the literature as Yawelmani) is parasitic on height. Similarly, rounding harmony in Mongolic is parasitic on height, requiring both trigger and target be [-high] (Kaun 2004). In Turkic, Cole & Kisseberth (1994) contend that Kazakh rounding harmony is parasitic on agreement for frontness. Besides the umlaut data under consideration here, additional evidence that [-high] segments are more active in backness harmony in Uyghur comes from the behaviour of dorsal consonants. Mayer *et al.* (2022) point out that uvular consonants tend to be stronger triggers

<sup>8</sup>A reviewer points out there is a second asymmetry between /æ/ and /ɑ/ involving the nonpast suffix /-i/, which triggers umlaut of /æ/ but not /ɑ/. Mayer *et al.* (2022) report that diachronically this suffix originated as a low vowel underspecified for backness /-A/, meaning it would surface as [æ] after /æ/ and [ɑ] after /ɑ/. I will not propose a synchronic analysis for this exceptional suffix, but presumably it can be related to the asymmetry of [æ] and [ɑ] in triggering umlaut under discussion in this section.

of backness harmony than velar consonants, including the derivational morpheme /-lUQ/ which tends to harmonise with uvulars that intervene between the suffix and a front vowel. Given the featural specifications in Hayes (2011), [+high] for velars and [-high] for uvulars, this is consistent with the parasitic harmony proposed here. The constraint in (49) encodes this preference for non-high vowels to agree in backness, which blocks umlaut in (50). Note that the statement of the constraint enforces parasitic harmony only between adjacent syllables. Since in the other cases of umlaut, the surface vowels either agree for backness or one of the vowels is [+high], this parasitic harmony constraint has no effect on the results established so far.

- (49) AGREE-[BK]/[-HI]: assign a violation to every pair of adjacent [-high] vowels that do not agree for the feature [back]

| /bɑlɑ/  | AGREE-[BK]/[-HI] | *HEAVY | ID-IO[HI] |
|---|------------------|--------|-----------|
| (50) a. bɑ <sub>μ</sub> μ. 'lɑ <sub>μ</sub> μ |                  | **     |           |
| b. bε <sub>μ</sub> . 'lɑ:μ <sub>μ</sub> μ     | *!               | *      |           |
| c. bi <sub>μ</sub> . 'lɑ:μ <sub>μ</sub> μ     |                  | *      | *!        |

As a reviewer helpfully points out, this proposal has a number of consequences that can be tested/investigated in further research. Wug testing with the verb root /bɑ/ should have differing behaviour for umlaut for different suffixes. It is predicted that umlaut will occur in /bɑ-βU/ ‘wug-GER’ which should surface as [be.βU] but not /bɑ-mɑq/ ‘wug-INF’ which should surface as [bɑ.mɑq]. Additionally, there should exist Uyghur words of the form [CeCuC] with underlying form /CɑCuC/, analogous to the examples for ‘green’ and ‘fish’ in (8). Finally, Uyghur speakers should judge harmony clashes to be more severe when they are between non-high vowels.

In sum, the current proposal treats “umlaut” in Uyghur as moderate vowel reduction rather than assimilation, but is constrained by parasitic harmony that is active in addition to the general backness harmony in the language. As such, the present analysis is able to successfully model the similarities between umlaut and raising, as well as the interaction between the two.

### 3.7. Constraint Ranking

To conclude, I will briefly summarise the final constraint rankings argued for in this section. The constraints in (51) are assumed to be undominated, since there is no evidence for them being violated in Uyghur.

- (51) \*4<sub>μ</sub>/σ, \*3<sub>μ</sub>/[-LO], W2S, WBP, LIC-MID/σ<sub>1</sub>, AGREE-[BK]/[-HI], \*3<sub>μ</sub>/σ & MAX-LINK-μ, \*2<sub>μ</sub>/[-LO] & MAX-LINK-μ

The ranking in (52) allows for consonants and moras to be deleted to ensure syllables have at most 3 moras.

(52)  $*4\mu/\sigma \gg \text{MAX-C}, \text{MAX-}\mu$

The ranking in (53) ensures that extra moras can be epenthesised if needed for stressed syllables or coda consonants.

(53)  $\text{W2S}, \text{WBP} \gg \text{DEP-}\mu$

The ranking in (54) ensures that vowel reduction and umlaut are blocked in closed syllables.

(54)  $\text{MAX-C}, \text{MAX-}\mu \gg *HEAVY/WK, *HEAVY$

The ranking in (55) ensures that low vowels cannot surface with a single mora, and if a low vowel only has a single mora associated with it, this will be repaired by raising to a high vowel rather than epenthesising a second mora as discussed in Section 3.5.

(55)  $\text{DEP-}\mu \gg *mu/[+LO] \gg \text{ID-IO}_{[HI]}$

The ranking in (56) ensures that umlaut cannot produce floating moras, but vowel reduction can if necessary as discussed in Section 3.4.

(56)  $*HEAVY/WK \gg *FLOAT \gg *HEAVY$

The ranking in (57) allows for vowel raising in heavy syllables.

(57)  $*HEAVY/WK, *HEAVY \gg \text{ID-IO}_{[LO]}$

The ranking in (58) ensures that umlaut in initial syllables can produce mid vowels, but word-medial vowel reduction must produce high vowels.

(58)  $\text{LIC-MID}/\sigma_1, *HEAVY/WK \gg \text{ID-IO}_{[HI]}$

The constraint ranking in (59) ensures that long high vowels do not lower.

(59)  $\text{ID-IO}_{[HI]} \gg *2\mu/[-LO]$

Finally, I assume the constraints in (60) do not dominate any other constraints.

(60)  $\text{MAX-LINK-}\mu, \text{DEP-LINK-}\mu$

#### 4. Alternatives

In the previous section I argued that putative umlaut and vowel raising in Uyghur are not distinct processes in the language but are variations of the same vowel reduction process. In this section I compare my analysis with several alternatives that all regard umlaut and raising as fundamentally distinct.

#### 4.1. Feature spreading

Recall from (13) that umlaut cannot be assimilatory. Harmony outputs sequences like [æ...æ] that are identical. However, in these contexts umlaut applies, outputting [e...æ]. This rules out the sort of basic feature spreading analyses suggested by previous authors (e.g., Nadzhip 1971; Yakup 2009). The pattern cannot involve spreading of some height feature, presumably [-low], because both [+low] and [+high] vowels are capable of triggering umlaut. There is thus no single height feature that describes the set of triggers since [+high] as well as [+low] vowels may trigger umlaut.

Recall from Section 2.2 that there is good evidence that the pattern cannot involve spreading of [-back]. First and foremost, an [æ...æ] sequence would perfectly satisfy some constraint requiring agreement for frontness. Nonetheless, umlaut results in raising of the initial low vowel to [e]. Thus, umlaut in (13) cannot result from the influence of some markedness constraint compelling assimilation for frontness. Second, such an analysis would need to explain the differential behaviour of dorsal consonants for harmony and umlaut. Recall that dorsals are neutral with regard to umlaut (9). Also recall that dorsals alternate for backness harmony (5), even triggering harmony in the absence of a non-neutral vowel (6). If Uyghur umlaut was spreading of [-back], we would expect /ɑβz/ ‘mouth’ (cf. 9) to surface as \*[e.giz] rather than [e.biz]. Third, a spreading analysis must explain why closed syllables are immune to umlaut though they are entirely subject to vowel harmony elsewhere in the language (5).

If, as I have argued, Uyghur umlaut is actually vowel reduction, then there is no need to define a spreading feature, nor is there any need to explain the behaviour of dorsal consonants or closed syllables. Since umlaut isn’t assimilation, there is no reason why the dorsals should interact with the pattern. Under my analysis, blocking by coda consonants derives from the same reasons that coda consonants block vowel raising, their contribution of a mora.

#### 4.2. Uyghur umlaut as true umlaut/metaphony

Since umlaut targets initial syllables, and some work on Turkic argues that initial syllables are stressed (e.g., Johanson 2022), one could plausibly contend that Uyghur is simply another instance of the sorts of patterns shown in (2-3). Construed this way, umlaut involves positional licensing of some feature from a post-tonic vowel to overwrite the stressed initial-syllable low vowel (Walker 2005, 2011; Kaplan 2015). Since positional licensing requires an asymmetric relationship between a uniquely prominent target and a weak trigger, it is incumbent upon such an analysis to explain the sets of triggers and targets in these terms. Yet, regardless of the particular feature involved, there are two empirical challenges based on exceptional stress for any analysis that requires umlaut to target stressed syllables. I will show that Uyghur has both stressed open syllables that do not undergo umlaut, and unstressed open syllables that do undergo umlaut.

Hahn (1991: 52–57) argues that vowel raising does not affect long vowels (61; cf. Mayer 2021), yielding output forms with low vowels in medial open syllables, contrary to the raising data in Section 2.3. Vowel length is thought to correlate with stress in these words (Mayer 2021), meaning the stress is not final in the examples

in (61). Notably, the stressed/long vowels cannot reduce, which is argued to be due to an ID-STRESS constraint (Mayer 2021: 200) that prevents underlying stress assignment from being overwritten for default final stress. Then, because W2S  $\gg$  \*HEAVY/WK  $\gg$  \*HEAVY, the stressed syllable will not undergo reduction.

- (61) a. /hɑwɑː-dɑ/ [hɑ.wɑː.dɑ] weather-LOC  
 b. /bɪnɑː-dɑ/ [bɪ.nɑː.dɑ] building-LOC

Hahn (1991: 55) shows that umlaut also fails to apply to long vowels (62); the long vowel in (62a) surfaces faithfully while the short vowel in (62b) is raised to [e]. This can also be captured with exceptional stress, meaning umlaut and vowel raising behave almost identically with respect to vowel length and exceptional stress.

- (62) a. /tæːr-i/ [tæː.ri] complexion-3.POSS  
 b. /tæːr-i/ [te.ri] sweat-3.POSS

This is unexpected if umlaut is thought to target stressed syllables. If the Uyghur pattern is a form of umlaut/metaphony, the resistance of long vowels to both umlaut and raising must be stipulated (cf. Calabrese 2011 on the independence of vowel length and metaphony in Italo-Romance; though see Kaplan 2023 on Bolognese).

In addition to vowel length, stress induced by exceptional suffixes is even more problematic for any analysis of Uyghur as true umlaut/metaphony. Like regular stress in Uyghur, descriptions vary on the placement of exceptional stress in a handful of exceptional morphemes described in the literature.<sup>9</sup> However, all descriptions consistently report that stress falls on the syllable preceding the unrestrained action suffix /-wær/, which I gloss as WER (Engesæth *et al.* 2009; Özçelik 2015; Fiddler 2021).

- (63) a. /kæːl-wær-βɑn/ [ke.'li.wær.gæːn] COME-WER-PFV  
 b. /βɑr-wær-f/ [be.'ri.wɛ.ri] GO-WER-GER

The examples in (62) showed stressed syllables resisting umlaut. In (63b), we see an unstressed syllable undergoing umlaut. The fact that the vowel in /-wær/ undergoes umlaut exactly like word-initial vowels argues against any stress-targeting positional licensing account. Example (63b) seems to also contradict the proposal in this paper that umlaut targets initial syllables, but I will address this in the next section.

### 4.3. Uyghur umlaut as initial-syllable overwrite

Since stress does not provide a reliable diagnostic for the application of umlaut, one could imagine the pattern actually targets the initial syllable. Initial syllables are known to exhibit prominence cross-linguistically (Beckman 1997, 1998); positional licensing patterns, e.g. umlaut in Chamorro, are known to target the root-initial syllable (Kaplan 2015). The initial-syllable overwrite analysis still suffers from several serious flaws.

<sup>9</sup>For instance, Engesæth *et al.* (2009) reports stress on the syllable preceding /-wɑt/ 'PROG' but Fiddler (2021) suggests stress may fall optionally on /-wɑt/ or the preceding syllable. If it is the case that umlaut occurs in a form where stress falls on /-wɑt/, then analysing umlaut on this morpheme, e.g., /βɑr-wɑt-f/ → [be.ri.wɛ.ti] 'go-PROG-GER', would be a challenge for my analysis and any analysis predicting non-reduction in stressed syllables.

Since overwrite patterns involve some feature(s) from a weak trigger affiliating with a strong licensing position, a similar characterization ought to be available for Uyghur. In Italo-Romance, weak post-tonic high vowels trigger overwrite of prominent stressed vowels. Similarly, in Chamorro, a weak prefix triggers overwrite of the prominent root-initial syllable. Yet, triggers for umlaut in Uyghur may be root-internal (8-9) or suffixal (4). There is thus no particular morphological weakness to motivate a licensing analysis since umlaut applies within roots (8). Moreover, if one accepts the common assertion that stress is final in Uyghur, there is no particular prosodic weakness common to umlaut triggers. Unstressed word-medial vowels (13c) as well as stressed word-final vowel may trigger umlaut (4). There is no convincing evidence that Uyghur umlaut really involves the sort of asymmetric trigger-target relation found in Italo-Romance metaphonies. However, a reviewer points out that the weakness of the trigger might not be related to morphology or stress but simply the linear-order dimension, in which all non-initial syllables are weak (Kaplan 2015). Yet even with a way to define a weak trigger, an overwrite analysis cannot account for the [-high, -low] feature combination that the initial syllable surfaces with. For example, umlaut in /æ...æ/ forms such as (13) lacks a [-low] feature on the trigger. One would have to stipulate a floating [-low] on all suffixes and roots where umlaut of /æ/ occurs before [æ], which is rather unsatisfactory.

Though I have rejected the analysis of umlaut as initial syllable overwrite, I still claim it is limited to initial syllables, and so the cases of seemingly word-medial umlaut in (63) require explanation. I will not give a full-fledged analysis, but I propose that these forms result from interesting behaviour at the syntax-phonology interface. There are four suffixes that can undergo word-medial umlaut (Mayer *et al.* 2022). I focus on /wær/ here, but all these suffixes display exceptional behaviour regarding stress (Fiddler 2021) and vowel harmony (64).

(64) /aŋla-wær-di/ [aŋ.la.wær.di] listen-WER-3.PST

In (64), /-wær/ does not harmonise to the root and begins its own harmony domain. Interestingly, all these exceptional suffixes were diachronically formed from multiword converbial expressions (Fiddler 2021) and synchronically appear higher than *v* and lower than *T* in the verbal domain. In a contextual phasehood approach (e.g. Bošković 2014), this makes a good case for these to be phase heads. Fenger (2020) looks at similar data in Turkish, in which certain Aspect heads exhibit exceptional behaviour regarding stress and harmony. She analyses these as marked phase heads which trigger spell-out and the subsequent insertion of phonological material of a sub-word domain. Fenger's approach predicts multiple phonological words within a single syntactic word. Within Uyghur, although they do not consider the suffixes under discussion here, Major *et al.* (2023) and Kodner (2024) look at words derived via head movement, with the possibility of multiple or nested prosodic words within a single syntactic word. Given that Fenger, Major *et al.*, and Kodner all use vowel harmony as a diagnostic for prosodic wordhood, I argue the prosodification of (64) is as given in (65).

(65) (aŋla)<sub>ω</sub> (wærdi)<sub>ω</sub>

This is the same as the prosodification proposed for auxiliaries in both Turkish and Uyghur. The crucial part of this proposal is that /-wæɪ/ is a marked phase head that triggers the spell-out of its complement (Chomsky 2000, 2001) and subsequent insertion of phonological material (Fenger 2020). This is what results in two different prosodic words, identified by the vowel harmony domains. It also explains why the final syllable of the root does not undergo vowel reduction, since that position is word-final in (65). This is consistent with the description of /-wæɪ/ as pre-stressing. Furthermore, it explains why /-wæɪ/ undergoes umlaut in (63b), as it is in initial position within a prosodic word.

## 5. Conclusion

This paper examined two vowel reduction processes in Uyghur, umlaut and vowel raising. Though umlaut has been treated as regressive assimilation in previous work, I have argued that Uyghur umlaut is not an assimilatory pattern like the patterns seen in Italo-Romance (Calabrese 2011) or Old High German (Ellis 1966). Instead, umlaut is actually a moderate form of the same vowel reduction pattern, often called vowel raising, already found in Uyghur. The differences between Uyghur umlaut and vowel raising – their different outputs, their complementary distribution, and umlaut’s apparent need for a triggering vowel in the following syllable – were either explainable through other facts of Uyghur phonology or deemed spurious. The account of Uyghur umlaut and vowel raising proposed in this paper builds on the sonority-based analysis in McCollum (2020), extending McCollum’s proposal to account for umlaut in addition to raising. Further, the paper invokes autosegmental representations to analyse both umlaut and vowel raising as mora-delinking in unstressed syllables, and as such offers an explanation for the interaction between vowel raising and umlaut in Uyghur (cf. Vaux 2023).

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