

# Issues in Uyghur Phonology<sup>1</sup>

Connor Mayer, Adam McCollum, and Gülnar Eziz

## Abstract

This article presents an overview of several significant aspects of the phonology of Uyghur (ISO: uig; pronounced [ɔj'kʊɾ]; Turkic: China). In addition to summarizing previous research, we present new data and highlight its relevance for phonological theory. The paper focuses primarily on the processes of backness harmony, rounding harmony, and vowel reduction. Particular attention is paid to the complex, and sometimes opaque, interactions between these processes, as well as the role of phonological exceptionality.

## 1. Introduction

Uyghur is a southeastern Turkic language spoken by roughly 12 million people. Its speakers are located primarily in the Xinjiang Uyghur Autonomous Region in the People's Republic of China, but there are also significant diasporic communities in neighboring Central Asian countries, such as Kazakhstan, Kyrgyzstan, and Uzbekistan, as well as smaller communities in Turkey, the United States, Canada, Australia, Russia, Saudi Arabia, Afghanistan, Pakistan, India, and Europe. There are an estimated 2 million diasporic speakers (Nazarova & Niyaz, 2013).

Uyghur is a highly agglutinating language, almost exclusively suffixing, with SOV word order and a rich case marking and agreement system. It is typologically most similar to modern Uzbek (Engesaeth, et al., 2009/2010; Nazarova & Niyaz, 2013).

Although there have been a number of detailed pedagogical or descriptive treatments of Uyghur phonology (e.g., Nadzhip, 1971; Hahn, 1991b; Comrie, 1997; de Jong, 2007; Engsaeth et al., 2009/2010; Abdulla et al., 2010; Nazarova and Niyaz, 2013, 2016), relatively little theoretical work has been done. The goal of this paper is to provide a broad overview of some of the most interesting aspects of Uyghur phonology, focusing on segmental phonology. We provide references to previous research where it exists. In cases where a topic of interest has not been carefully studied, we provide illustrative data as well as a characterization of its theoretical significance. We hope that this might serve as a starting point for researchers interested in better understanding this language and its relevance for various aspects of phonological theory.

We will focus on the phonology of three broad areas: backness harmony, rounding harmony, and vowel reduction. Two broad themes run through the paper: complex, and often opaque, interactions between these processes, and morpheme-specific exceptionality. We will show that Uyghur can provide insight into the nature of lexical representations, the representation of opacity and exceptionality in the grammar, and the kinds of productive generalizations speakers learn from language data.

---

<sup>1</sup> The authors would like to thank the Uyghur community in Kazakhstan for their willingness to share their language and culture with us. We also thank Michael Fiddler, Bruce Hayes, Tim Hunter, Travis Major, and Kie Zuraw for feedback on earlier drafts, and Mahire Yakup for her insights into Uyghur phonetics and phonology.

## 2. Uyghur backness harmony

Broadly speaking, backness harmony requires certain vowels and consonants in suffixes (undergoers) to agree for the feature [back] with certain vowels and consonants in the root (triggers). Turkic roots tend to be harmonic, containing only [+back] or [-back] sounds. However, a large number of borrowings from Persian, Russian, Arabic, and Chinese, many of which are quite old, have resulted in a high degree of root-internal disharmony in the language (that is, roots that contain a mixture of front and back vowels and/or consonants).

Backness harmony is therefore most evident as a morphophonological process where segments in many suffixes must agree in backness with the stems to which they attach. Diachronic change has made the Uyghur harmony system more descriptively complicated as well as more computationally complex than similar systems in related languages (Mayer & Major, 2018), in that it requires more powerful/less restrictive mathematical formalisms to express its behavior (e.g., Heinz, 2018). The development of transparent vowels has led to (a) consonants serving as triggers for harmony; (b) a class of roots that must be lexically specified for harmonizing behavior; and, (c) opacity in the harmony system, via interaction with vowel raising processes.

### 2.1 Participating segments

The Uyghur vowel phonemes are shown in Table 1. The underlined vowels /u y o ø æ/ are those that serve as triggers of backness harmony processes, while the non-underlined vowels /i e/ are harmonically neutral, or transparent. The sets of high and low trigger vowels also undergo harmony, while the mid vowel triggers do not. Mid vowels are virtually unattested in suffixes: the sole exception is the non-harmonizing derivational suffix /-χor/ ‘eater’, derived from Persian /xordan/ ‘to eat’: e.g., /gøfχor/ ‘carnivore (lit. meat-eater)’. This suffix is not productive. Mid rounded vowels may occur in non-initial syllables in the Lopnor dialect due to the dialect’s rounding harmony pattern, which targets non-high vowels (Abdurehim, 2014: 77-78).

	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>a</u>	

**Table 1:** The Uyghur vowel system. Harmonizing vowels are underlined.

Although these are the standard symbols used to transcribe these vowels, they are generally produced less peripherally than their transcriptions would indicate. The vowel transcribed as /æ/ is acoustically intermediate between cardinal [æ] and [ɛ]. The vowels transcribed as /u y o ø/ are generally produced closer to [ʊ ʏ ɔ œ] respectively. The neutral vowels, particularly /i/, display a much greater susceptibility to coarticulation than the harmonizing vowels. Hahn (1991b) describes no less than fourteen allophones

of /i/, ranging from [u] to [ə] to [ɪ] to [i], and Mayer et al. (2022) demonstrate a strong influence of adjacent consonant place on the acoustic realization of /i/. /e/ may surface as [ɛ], [e], or [i], with the latter a common allophone in initial syllables. Thus although these vowels are phonemically transcribed as non-low front vowels, the reader should keep in mind that their phonetic realization varies.

In addition to vowels, a subset of the dorsal consonants also participate in the harmony system. These are shown in Table 2. These consonants both trigger and undergo backness harmony.<sup>2</sup> The backness of these consonants is generally predictable when they occur in suffixes (see Section 2.2), but there exist root minimal pairs differing only in backness, such as /kir/ ‘dirt’ and /qir/ ‘edge’

	Front	Back
Voiceless	k	q
Voiced	g	ɣ

**Table 2:** Harmonizing Uyghur consonants

## 2.2 Determining suffix backness

Many suffixes in Uyghur vary in their pronunciation depending on the backness, rounding, or voicing of preceding material. We assume for the purposes of this paper that the alternating phonemes in these suffixes are underspecified for the relevant features (Archangeli, 1988), though this is not crucially important. We use the following symbols:

- /A/ represents a low unrounded vowel that is unspecified for backness ([æ ɑ]).
- /U/ represents a high vowel that is unspecified for backness and rounding ([u y i]).
- /K/ represents a voiceless dorsal consonant that is unspecified for backness ([k q]).
- /G/ represents a dorsal consonant that is unspecified for voicing and backness ([k g q ɣ]).
- /D/ represents a coronal stop that is unspecified for voicing ([t d]).

Harmonically invariant segments in roots and harmony-blocking suffixes are assumed to be fully specified for backness and roundness (e.g., Nevins, 2004).

In the examples below, we use nouns with the locative suffix /-DA/ (surface forms: [-tɑ], [-dɑ], [-tæ], [-dæ]), the plural suffix /-lAr/ (surface forms: [-lɑr], [-læɾ]), and the dative suffix /-GA/

<sup>2</sup> Abdulla et al. (2010) suggest that /ɣ/ also serves as a back trigger, but evidence for this is equivocal, as it is not an undergoer of harmony in the same way as /q/ or /ɣ/. The velar nasal /ŋ/ does not appear to participate in the harmony process, though it does have an allophonic backing effect on adjacent vowels (Mayer et al., 2022).

(surface forms: [-qɑ], [-ɤɑ], [-kæ], [-gæ]).<sup>3</sup> Voicing alternations in the initial segment are caused by voicing assimilation, and are orthogonal to harmony.<sup>4</sup>

The basic characterization of backness harmony is that suffixes must agree in backness with the final front /y ø æ/ or back /u o ɑ/ harmonizing root vowel.

- (1) *Simple front harmonizing forms*
- |                        |              |
|------------------------|--------------|
| <b>tyr-dæ</b> /*-da    | ‘type-LOC’   |
| <b>pæn-lær</b> /*-lar  | ‘science-PL’ |
| <b>munbær-gæ</b> /*-ɤɑ | ‘podium-DAT’ |
- (2) *Simple back harmonizing forms*
- |                       |                    |
|-----------------------|--------------------|
| <b>pul-ɤɑ</b> /*-gæ   | ‘money-DAT’        |
| <b>top-qa</b> /*-kæ   | ‘ball-DAT’         |
| <b>ætrap-ta</b> /*-tæ | ‘surroundings-LOC’ |

The vowels /i e/ are *transparent* to harmony, meaning that they do not serve as harmony triggers for suffixes, but allow the harmonic value of preceding segments to “pass through” them:

- (3) *Front roots with transparent vowels*
- |                         |                |
|-------------------------|----------------|
| <b>mæstʃit-tæ</b> /*-ta | ‘mosque-LOC’   |
| <b>y mid-lær</b> /*-lar | ‘hope-PL’      |
| <b>mømin-gæ</b> /*-ɤɑ   | ‘believer-DAT’ |
- (4) *Back roots with transparent vowels*
- |                             |                  |
|-----------------------------|------------------|
| <b>student-lar</b> /*-lær   | ‘student-PL’     |
| <b>uniwersitet-ta</b> /*-tæ | ‘university-LOC’ |
| <b>amil-ɤɑ</b> /*-gæ        | ‘element-DAT’    |

Roots containing only transparent vowels and no harmonizing dorsals (‘neutral roots’) vary in whether they take front or back suffixes. The majority take back suffixes, but some take front suffixes.

---

<sup>3</sup> The dative suffix may also surface as [-qæ] when attached to a root with a front vowel that ends in a voiceless uvular, as in [χæɫq-qæ] ‘people-DAT’ (cf. [χæɫq-i-gæ] ‘people-3.POS-DAT’). We consider this to be a case of local place assimilation rather than harmony, though some previous work has described greater significance to it (e.g., Pattillo, 2013). Additional evidence that this is assimilation rather than harmony comes from Standard Uzbek, which is closely related to Uyghur. Although Uzbek has completely lost vowel harmony, an identical kind of place assimilation happens in the initial consonant of the dative suffix, which surfaces as [-qɑ] when attached to roots ending in a uvular, but [-kɑ] or [-gɑ] when attached to other roots.

<sup>4</sup> Suffixes containing high vowels that alternate for backness are also subject to rounding harmony. We abstain from discussing them here for the sake of clarity. Examples of such forms are found in Section 3.

(5) *Neutral roots that take back suffixes*

sir-lar/*-lær	‘secret-PL’
din-ɤɑ/*-gæ	‘religion-DAT’
hejt-tɑ/*-tæ	‘festival-LOC’
peʔil-lar/*-lær	‘verb-PL’
tip-qɑ/*-kæ	‘type-DAT’

(6) *Neutral roots that take front suffixes*

biz-gæ/*-ɤɑ	‘us-DAT’
bilim-gæ/*-ɤɑ	‘knowledge-DAT’
welsipit-lær/*-lar	‘bicycle-PL’

Roots with only transparent vowels that contain harmonizing dorsal consonants typically harmonize according to the backness of these dorsals. Roots with back dorsals (7) invariably take back suffixes. Roots with front dorsals typically take front suffixes (8), but a number of recent loanwords take back suffixes (9). Roots such as those in (9) often do not categorically take back suffixes, but take them more frequently than is typical for such roots.

(7) *Roots with only back dorsals*

qiz-lar/*-lær	‘girl-PL’
jiɤin-dɑ/*-dæ	‘meeting-LOC’

(8) *Roots with only front dorsals*

kishi-lær/*-lar	‘person-PL’
negiz-gæ/*-ɤɑ	‘basis-DAT’

(9) *Exceptional front dorsal roots with back suffixes*

rentigen-ɤɑ/-gæ	‘x.ray-DAT’
gips-qɑ/-kæ	‘plaster-DAT’

The distribution between of front and back suffixes for the front dorsal roots in (8) and (9) differs from the distribution for the neutral roots in (5) and (6): the majority of neutral roots takes back suffixes, while the majority of front dorsal roots takes front suffixes. Thus front dorsals do appear to be front harmony triggers, but their effect is weaker than vowels and back dorsals (see Mayer, 2021, Ch. 4 for a quantification of these distributions from corpus data).

In cases where a harmonizing dorsal occurs between a following suffix and a preceding vowel that conflicts in backness, the backness of the vowel dictates the form of the suffix.

(10) *Harmony conflicts between a vowel and a following dorsal*

mæntiq-qæ/*-qɑ	‘logic-DAT’
æqil-gæ/*-ɤɑ	‘intelligence-DAT’
rak-lar/*-lær	‘cancer-PL’
pakit-lar/*-lær	‘fact-PL’

A small set of roots containing uvular consonants violates this generalization.

- (11) *Exceptional roots with conflicting front vowels and uvulars where the uvular takes precedence*
- |                  |                |
|------------------|----------------|
| tæstiq-qɑ/*-kæ   | ‘approval-DAT’ |
| tæfwiq-lar/*-lær | ‘publicity-PL’ |
| tætqiq-lar/*-lær | ‘research-PL’  |

Finally, there are also at least a few words or phrases where suffixes do not always agree in backness with the final harmonizing vowel.

- (12) *Optional harmony exceptions*
- |                      |  |
|----------------------|--|
| sowet-lær/-lar       | ‘soviet-PL’  |
| deñiz sahil-i-gæ/-ka | ‘ocean shore-3.POS-DAT’ (cf. [sahil-ka] ‘shore-DAT’) |

### 2.3 Theoretical analyses of transparent vowels

To account for the behavior of transparent vowels, particularly for the idiosyncratic behavior of neutral roots, some researchers have proposed /u/ and /ʏ/ as underlying back phonemic counterparts to /i/ and /e/ (e.g., Lindblad, 1990; Hahn, 1991a, 1991b). This contrast is claimed to be neutralized on the surface by a post-lexical fronting rule whereby underlying /u/ and /ʏ/ are fronted to [i] and [e] in all contexts after vowel harmony has applied. Under this account, harmony is entirely vowel-driven. Transparent vowels are either underlyingly specified for backness, or inherit the [back] value of the preceding harmonic vowel. The apparent correlation between dorsal backness and suffix backness is due to co-occurrence restrictions between dorsals and vowels in roots: that is, dorsals in a root are underlyingly unspecified for backness and must agree in backness with root vowels. The behavior of so-called neutral roots is entirely due to the underlying [back] value of their final vowel.

Example derivations under this analysis for the forms [kir-gæ] ‘dirt-DAT’ and [qiz-ka] ‘girl-DAT’ are shown below.

(13)	<b>UR</b>	/Kir-GA/	/Kʏz-GA/
	<b>Harmony</b>	kirgæ	qʏz-ka
	<b>Neutralization</b>	–	qiz-ka
	<b>SR</b>	[kirgæ]	[qizka]

This analysis effectively recapitulates the diachronic process that led to transparent vowels in Uyghur. Scholars generally agree that Old Turkic and Chagatay (the direct ancestor of Uyghur and Uzbek) had a phonemic contrast between /i/ and /u/ in initial syllables (Lindblad, 1990; Hahn, 1991a, 1991b; Bodrogligeti, 2001; Erdal, 2004).<sup>5</sup> At some point in its history, Uyghur lost the surface distinction between [i] and [u], which complicated the harmony system (at least superficially), introducing transparent vowels, neutral roots, and consonants as harmony triggers.<sup>6</sup> Lindblad (1990) notes that the

<sup>5</sup> Though see, e.g., Johanson (1998) for a critical perspective.

<sup>6</sup> See also Binnick (1991) for discussion of the inherent instability of harmony systems, and how this results primarily from language-internal factors, rather than loanwords.

most frequent roots that previously had /i/ continued to take front suffixes (e.g., /biz/ ‘we’, /ilim/ ‘knowledge’, /it̪-/ ‘drink’), the roots that previously had /u/ continued to take back suffixes, and many less frequent roots with underlying /i/ began to take the default back form of suffixes. If the default harmony value in Uyghur is indeed [+back], despite the fact that transparent vowels are [–back], this would make Uyghur typologically unusual (and thus of theoretical interest). In languages such as Mongolian and Finnish, which have similar transparent vowels, transparent roots generally behave as [–back] (Lindblad, 1990).

Evidence for [+back] as the default, or unmarked, category is not entirely conclusive, however. Aside from the synchronic and diachronic behavior of neutral roots described above, there are several factors in support of a [+back] default. First, back vowels and consonants are more frequent in the lexicon than front vowels and consonants (Mayer, 2021; p. 122). Second, there is an asymmetry between the weak front and back consonant triggers: roots with weak front triggers will sometimes take back suffixes, but roots with weak back triggers seldom take front suffixes (see Mayer 2021; Ch. 4). Finally, wug test results from Mayer (2021; Ch. 4) show an asymmetric effect of distance-based decay (e.g., Hayes and Londe, 2006; Hayes et al., 2009; Kimper, 2011; Zymet, 2014) on front and back vowels. As the number of transparent vowels that intervene between the final front vowel in a root and the first suffix increases (i.e., as the vocalic template of the root goes from F → FN → FNN, where F is a front vowel and N is a transparent vowel), speakers become more likely to choose back suffix forms. However, in similar configurations where the final harmonizing vowel is back (i.e., as the vocalic template of the root goes from B → BN → BNN, where B is a back vowel), speakers do not show a corresponding increase in front suffix responses. Mayer interprets this as evidence for [+back] suffix forms as the default.

There is also evidence, however, that suggests [–back] as the default. First, McCollum (2019) notes that long sequences of harmonizing front vowels display relatively consistent phonetic frontness, as measured by the second formant. Similar sequences of harmonizing back vowels, however, gradually become fronter throughout the sequence (p. 135). This is interpreted as drift towards the default front articulatory setting, which has been claimed to correspond to the unmarked value (e.g., Hudu, 2010; Allen et al. 2013). Second, borrowings into Uyghur from Persian or Arabic often convert back vowels in the source language into front vowels in Uyghur (e.g., Persian /goʃt/ → Uyghur /gøʃ/ ‘meat’; Arabic /ʔumr/ → Uyghur /ømyr/ ‘life’), while adapting front vowels into back vowels in loans appears to be exceedingly rare if not unattested.

One possible analysis that reconciles the phonetic observations from McCollum (2019) with the idea that [+back] is the default is that phonologically unmarked values permit greater amounts of non-distinctive variation than marked values (Hockett, 1955; Greenberg, 1966). Put differently, marked values have more precise perceptual targets than unmarked values. Thus sequences of unmarked back vowels in harmonizing suffixes gradually drift towards a default, fronter articulatory setting, while sequences of marked front vowels are under greater pressure to maintain more precise phonetic targets. More research is needed to address this issue.

Mayer et al. (2022) proposes an alternative account of neutral roots based on lexical exceptionality. Given a covert phonemic contrast, one surprising property of Uyghur is the total absence of homophonic neutral roots that differ in the backness of suffixes they take (i.e., underlying minimal pairs between /i/-/u/ and

/e/-/ɤ/), even though such pairs are plentiful for other vowel pairs. The closest thing is a small set of noun-verb pairs that contain the same roots, but differ in their harmonizing behavior (e.g. [iz-lɑr] ‘trace-PL’ vs. [izli-mæk] ‘search-INF’, derived from /iz/ plus the verbalizing suffix /-lɑ/ and the infinitival suffix /-mæk/; see Mayer et al. 2022 for more details). In addition, many cases of phonological neutralization have resulted in subtle phonetic distinctions that reflect the original contrast, but are typically not perceived by speakers (e.g., Labov, 1972; Yu, 2007). Acoustic analyses of neutral roots in Uyghur, however, find no clear correlation between vowel F2 in neutral roots and whether such roots take front or back suffixes (e.g., McCollum, 2021; Mayer et al., 2022).

Mayer et al. propose that the majority of neutral roots take the default [+back] suffixes, and the small number of roots that take [-back] suffixes are represented as lexical exceptions. This account claims to be more parsimonious from the perspective of learning: speakers do not need to intuit the existence of a phonemic contrast that is never directly signaled on the surface. It also more clearly accounts for the relationship between exceptionality and frequency (see, e.g., Bybee, 1985; Morgan and Levy, 2016; Moore-Cantwell, 2018), unifying the behavior of neutral roots with other exceptional phonological patterns in the language.

## 2.4 Morphologically-conditioned exceptions to backness harmony

Suffix-specific exceptionality in Uyghur backness harmony includes suffixes that prefer to harmonize with consonants over vowels and a number of harmony blocking suffixes that impose their own backness on following suffixes

The derivational morpheme /-lUQ/ (surface forms [-lik], [-liq], [-lyk], [-luq]) behaves idiosyncratically, with a tendency to harmonize with uvulars when they intervene between the suffix and a preceding front vowel (see also Becker, 2016). In the forms below, we would expect [-lik] given the preceding front vowel, but we instead see the back from [-liq].

(14) *Idiosyncratic harmonization of /-lUQ/*

mæntiq-qæ	‘logic-DAT’	mæntiq-liq	‘logical’
æqil-gæ	‘intelligence-DAT’	æqil-liq	‘intelligent’
hæq-qæ	‘wage-DAT’	hæq-liq	‘paid (adj.)’

Subsequent suffixes harmonize as expected with the preceding vowel trigger: e.g., [pærq-liq-lær] ‘difference-LIQ-PL (different ones)’.

There are also a number of suffixes in Uyghur that do not harmonize, and may impose their own harmonic value on the remainder of the word. These suffixes include the progressive suffix /-wat/ (as well as the other similar suffixes described in Section 4.1.2), the similitude marker /-Dæk/, the locative relativizer /-Diki/, the genitive relativizer /-niŋki/, the imperfective participle /-diŋan/, and most suffixes that mark person and number on verbs.

(15) *Examples of non-harmonizing suffixes*

/kyl-wat-GAn/	→	[kyl-iwat-qan]	‘laugh-PROG-PERF’
<i>cf.</i> /kyl-GAn/	→	[kyl-gæn]	‘laugh-PERF’
/rajon-lAr-Diki-GA/	→	[rajon-lar-diki-gæ]	‘region-PL-LOC.REL-DAT’
<i>cf.</i> /rajon-lAr-GA/	→	[rajon-lar-ɤa]	‘region-PL-DAT’
/ujɤur-lAr-niŋki-GA/	→	[ujɤur-lar-niŋki-gæ]	‘Uyghur-PL-GEN.REL-DAT’
<i>cf.</i> /ujɤur-lAr-GA/	→	[ujɤur-lar-ɤa]	‘Uyghur-PL-DAT’
/taf-Dæk/	→	[taf-tæk]	‘stone-SIMIL (stone-like)’
/køn-i-du/	→	[køn-i-du]	‘accept-NONPAST-3’
/sat-i-mæn/	→	[sat-i-mæn]	‘sell-NONPAST-1.SG’

There is at least one suffix which is a partial harmonizer: the delimiting suffix /-Gitʃæ/. This suffix surfaces as either [-kitʃæ], [-gitʃæ], [-qitʃæ], [-ɤitʃæ], with the initial consonant harmonizing but the final vowel remaining front in all contexts.

(15) *Examples of partially harmonizing suffixes*

/ɤuldʒa-Gitʃæ/	→	[ɤuldʒa-ɤitʃæ]	‘Ghulja-DELIM’
/yrymtʃi-Gitʃæ/	→	[yrymtʃi-gitʃæ]	‘Ürümchi-DELIM’

It is unclear whether this suffix imposes its own harmonic value because suffixes are not typically attached to forms ending in /-Gitʃæ/.

## 2.5 Theoretical relevance of Uyghur backness harmony

The Uyghur backness harmony system provides useful insights into several aspects of phonological theory. First, as a backness harmony system, it is unusually complex: it contains both strong (vowel) and weak (consonant) harmony triggers, with consonants only serving as clear triggers in the absence of harmonizing vowels. It also contains transparent vowels. Although this complexity makes Uyghur a useful proving ground for theories of backness harmony, there has been relatively little theoretical work on this topic. Pattillo (2013) argues that Uyghur does not display consonant harmony according to the definition in Hansson (2001), assuming a similar analysis to Lindblad (1990) and Hahn (1991b) to account for roots with no harmonizing vowels. Becker (2016) presents an analysis of some of the vowel-consonant interactions described above using an Agreement by Correspondence analysis (Hansson, 2001; Rose and Walker, 2004).

The treatment of neutral roots in Uyghur also bears on the nature of lexical representations: under the analyses proposed by Lindblad (1990) and Hahn (1991b), speakers represent these harmonically ambiguous roots with abstract phonemes that are never realized on the surface. Mayer (2021) and Mayer et al. (2022) suggest that speakers’ lexical representations correspond more closely to the surface realizations of these roots, with cases of idiosyncratic harmonizing behavior represented as lexical

exceptions. These two hypotheses bear directly on the division of labor between phonology and morphology.

One might also wonder whether speakers fully internalize all the complexities of the harmony system into their productive phonological grammars (e.g., Hayes et al., 2009; Becker et al., 2011). Discrepancies between patterns in the ambient language data and the generalizations made by Uyghur speakers can provide insight into the phonological learning process and any biases that learners might bring to the table. Some preliminary work has been done on this topic. Mayer (2021, Ch. 4) shows that speakers generalize harmony patterns to wug words in unexpected ways: despite a robust tendency in attested words for the front dorsals /k g/ to serve as weak triggers for front suffix forms, they do not do so in wug word judgements (though the back dorsals /q ƣ/ do). Mayer interprets this as a phonetic bias in phonological learning: uvulars induce greater coarticulatory effects than velars, and thus are internalized as stronger harmony triggers. These results are also consistent with Abdushalamu et al. (2020), who similarly find that consonants are also less consistent undergoers of harmony in a wug test task. In addition, Mayer finds evidence of asymmetrical distance-based decay (discussed above in Section 2.3), which is similarly absent in attested forms.

Finally, the harmony system is rife with exceptions, particularly in cases where roots have weak or no phonotactic cues to their harmonizing behavior. The treatment of exceptions in phonology is of perennial interest (see, e.g., Wolf, 2011), and the Uyghur backness harmony system (as well as many of the patterns described below) provide a valuable testing ground for theories of exceptionality.

### 3 Rounding harmony

Uyghur also has a process of rounding harmony. There is an asynchrony between triggers and undergoers in rounding harmony: any rounded vowel /u y o ø/ can serve as a trigger, but only the high vowels [u y] emerge as the outcome of rounding harmony.

Rounding harmony is exemplified by a number of suffixes that display alternations between [i], [y], and [u] depending on the root. If the final harmonizing vowel in the root is a rounded front vowel (/y ø/) the suffix form will contain [y]; if the final harmonizing root vowel is a rounded back vowel (/u o/) the suffix form will contain [u]; if the final harmonizing root vowel is unrounded, or if the root contains no harmonizing vowels, the suffix will contain [i]. This process typically occurs with suffixes that trigger vowel epenthesis, such as /-m/ ‘1Sg.POS’ or /-f/ ‘GER’. A high vowel is epenthesized between the root and suffix if the root ends in a consonant.

#### (16) Examples of rounding harmony on epenthetic vowels

/datʃa-m/	→	[datʃam]	‘villa-1Sg.POS’
/kɑz-m/	→	[kɛz-im]	‘goose-1Sg.POS’
/pær-m/	→	[pær-im]	‘feather-1Sg.POS’
/pul-m/	→	[pul-um]	‘money-1Sg.POS’
/gyl-m/	→	[gyl-ym]	‘flower-1Sg.POS’
/it-m/	→	[it-im]	‘dog-1Sg.POS’

Not all epenthetic vowels display mandatory rounding harmony. For example, /kyl-wat-GAn/ ‘laugh-PROG-PERF’ generally surfaces as [kyl-ɨwat-qan], though [kyl-ɯwat-qan] is also possible.<sup>7</sup>

The majority of non-epenthetic vowels do not display rounding harmony in the standard variety: e.g., /jyz-m-din/ → [jyz-ym-din] ‘face-1Sg.POS-ABL’. However, in other varieties of the language, rounding harmony applies more generally to high vowels, with forms such as the previous one surfacing as [jyz-ym-dyn] (Hahn 1991b; Yakup 2005:55,66; Abdurehim 2014:77-79; McCollum 2019:13-15). Hahn (1991b) and Abdurehim (2014:77-78) also report that in some varieties, e.g., the Lopnor dialect, non-high vowels are also underergoers of rounding harmony; e.g., /øj-GA/ → [øj-gø] ‘house-DAT’.

Despite the general immunity of underlying high vowels to rounding harmony in the standard variety of the language, a number of suffixes with underlying high vowels consistently display rounding harmony, such as /-IUQ/, which was described above.

- (17) *Examples of rounding harmony on non-epenthetic vowels*
- |             |   |             |                        |
|-------------|---|-------------|------------------------|
| /qorAl-IUQ/ | → | [qoral-liq] | ‘weapon-LIQ (armed)’   |
| /tæm-IUQ/   | → | [tæm-lik]   | ‘taste-LIQ (tasty)’    |
| /tuz-IUQ/   | → | [tuz-luq]   | ‘salt-LIQ (salty)’     |
| /øz-IUQ/    | → | [øz-lyk]    | ‘self-LIQ (reflexive)’ |

The vowel in this suffix agrees for rounding and backness with the root while the consonant agrees in backness (though the backness contrast on the vowel is only manifested when the triggering vowel is rounded, as there is no front-back contrast between high unrounded vowels).

Though rounding harmony – like backness harmony – appears to operate strictly from left to right, Hahn (1990b) also describes leftward rounding harmony in loan words with illicit initial clusters. Hahn reports that epenthetic vowels that repair these clusters are subject to harmony: e.g., [istatistika] vs. [guruppa].<sup>8</sup>

## 4 Vowel raising

Uyghur has two independent, though similar, phonological vowel raising processes. These processes are quite productive in the language, but generally occur only in derived environments: that is, these processes are not usually observed as restrictions on root phonotactics (with a few exceptions shown in Section 5.2), but as alternations triggered by suffixation.

### 4.1 Vowel reduction

The first vowel raising process, traditionally referred to as *vowel reduction*, raises the low vowels /a æ/ to [i] in word-medial open syllables. Examples of vowel reduction are shown below.

<sup>7</sup> It may be more accurate to consider alternations between [wat]~[iwat]~[ywat]~[uwat] allomorph selection rather than epenthesis, since Uyghur does not usually repair heterosyllabic CC sequences. The origin of /-Iwat/ as a contraction of the multi-word construction /-p jat-/ may account for the idiosyncratic behavior of this suffix with respect to both epenthesis and rounding harmony (see Section 4.1.2).

<sup>8</sup> Kaun (2000, 2004) points out a similar phenomenon in Turkish, though Bellik (2019) suggests this is the result of phonetic gestural overlap rather than phonological harmony.

- (18) */a/ vowel reduction*
- |        |              |         |                    |
|--------|--------------|---------|--------------------|
| bala   | ‘child’      | bali-ni | ‘child-ACC’        |
| apa    | ‘mom’        | api-si  | ‘mom-3.POS’        |
| aŋla-ʃ | ‘listen-GER’ | aŋli-di | ‘listen-3.SG.PAST’ |
| qara-ʃ | ‘look-GER’   | qari-di | ‘look-3.SG.PAST’   |
- (19) */æ/ vowel reduction*
- |         |              |          |                    |
|---------|--------------|----------|--------------------|
| apæt    | ‘disaster’   | apit-i   | ‘disaster-3.POS’   |
| mewæ    | ‘fruit’      | mewi-si  | ‘fruit-3.POS’      |
| søzlæ-ʃ | ‘talk-GER’   | søzli-di | ‘talk-3.SG.PAST’   |
| kytʃæ-ʃ | ‘strive-GER’ | kytʃi-di | ‘strive-3.SG.PAST’ |

This process generally applies only to derived environments. The root /maqalæ/ ‘academic article’, for example, surfaces as [maqalæ] rather than \*[maqilæ].<sup>9</sup>

The domain of vowel reduction can also be greater than the word, as noted by Hahn (1991b, p. 53). It is not uncommon to see word-final vowels raised in rapid speech, as in [adil hæŋæŋgi bærdi] ‘Adil gave it to Hesen’ (cf. the unraised [adil hæŋæŋæ bærdi]).

#### 4.1.1 Lexical exceptions to vowel reduction

Even in derived environments, vowel reduction does not apply exceptionlessly. Certain roots resist vowel reduction categorically, though this appears to be more common in loanwords where the relevant vowel is long in the source language (Nazarova & Niyaz 2013), and when the potential raiser is /a/.

- (20) *Exceptions to vowel reduction with /a/*
- |       |           |          |                 |
|-------|-----------|----------|-----------------|
| hawa  | ‘weather’ | hawa-si  | ‘weather-3.POS’ |
| dærja | ‘river’   | dærja-si | ‘river-3.POS’   |
| makan | ‘place’   | makan-i  | ‘place-3.POS’   |
- (21) *Exceptions to vowel reduction with /æ/*
- |          |            |         |                |
|----------|------------|---------|----------------|
| sæwæb    | ‘reason’   | sæwæb-i | ‘reason-3.POS’ |
| wæqæ     | ‘accident’ | wæqæ-gæ | ‘accident-DAT’ |
| æwæt-mæk | ‘send-INF’ | æwæt-ij | ‘send-GER’     |

Vowel reduction has been claimed to be sensitive to vowel length distinctions and/or stress, with long or stressed vowels failing to raise. The status of phonemic vowel length and stress in Uyghur is somewhat unclear, however. Hahn (1991b) claims that Uyghur has phonemic vowel length which is not represented orthographically, as well as lexical stress reflected by increases in pitch, duration, and intensity.

<sup>9</sup> A reviewer wonders if this could be analyzed as a vowel lowering process instead, where the quality of the lowered vowel is determined by harmony. This is impossible due to roots like /æsli/ ‘origin’, which have underlying /i/ in this position but do not display alternation: /æsli/ → [æsli]; /æsli-ni/ → [æsli-ni]. Such an analysis would also produce unexpected results for the opaque cases discussed in Section 5.1.

A series of production and perception experiments in Yakup (2013) and Yakup and Sereno (2016) suggests that lexical stress does exist, but is reflected only by increases in duration: however, Uyghur speakers frequently disagreed as to which syllables were stressed in many words. Major and Mayer (2018, to appear) reproduce and expand on these results, suggesting that phrasal prosody is responsible for pitch contours that have previously been attributed to stress. It is clear that Uyghur speakers perceive certain vowels as longer than others, but it is unclear whether this should be analyzed as underlying vowel length or lexically-specified stress (or both).<sup>10</sup>

There has been limited phonetic evidence brought to bear on the question of vowel reduction specifically (though see McCollum, 2020). Assuming a description of Uyghur stress that is broadly consistent with a number of existing papers (Yakup, 2013; Yakup and Sereno, 2016; Özçelik, 2015; Major & Mayer, 2018, to appear; McCollum, 2020), the relationship between vowel reduction and stress might be characterized according to the following properties:

1. Closed syllables and stressed syllables are heavy. Open syllables are light.
2. Initial and final syllables are both stressed by default.
3. Certain roots are lexically specified for stress position. The subset of this class of roots with fixed stress on the final syllable fails to undergo vowel reduction in the presence of suffixation.
4. Vowel reduction only targets light syllables. For example, the second vowel in [apa] ‘mother’ does not display vowel reduction because it is stressed, but the same vowel in [api-lar] ‘mother-PL’ does.

It will be important to bring additional phonetic data to bear on this proposal.

#### 4.1.2 Morphologically-conditioned exceptions to vowel reduction

There are also a number of morphological exceptions to vowel reduction beyond roots that simply fail to raise. Vowels in certain suffixes, such as the abilitative suffix /-AIA/, do not reduce, while vowels in others, such as the perfective suffix /-GAN/, do.

(22) *Examples of non-reducing suffixes*

jygyr-æɫæ-j-du/*jygyr-ilæ-j-du	‘run-ABIL-NONPAST-3’
bol-ala-j-du/*bol-ila-j-du	‘become-ABIL-NONPAST-3’

(23) *Examples of reducing suffixes*

jygyr-gin-i/*jygyr-gæn-i	‘run-PERF-3.POS’
bol-ɨin-i/*bol-ɨan-i	‘become-PERF-3.POS’

/-AIA/ is a grammaticalized contraction of what was once a multi-word phrase. In related Kazakh, abilitative constructions are still multi-word expressions, such as /bar-A al-A-mIn/ → [bara alamun] ‘I

---

<sup>10</sup> A factor in this uncertainty is the absence of clear minimal pairs based on vowel length. Hahn (1991a) proposes a distinction between /tær/ ‘sweat’ and /tæ:r/ ‘complexion’. He motivates this distinction because the former undergoes umlaut, /tær-i/ → [ter-i] ‘her sweat’, while the latter does not, /tær-i/ → [taer-i] ‘her complexion’ (see Section 4.2 of this paper for a description of umlaut).

am/will be able to go'. In these historical forms the conditional context for vowel reduction was not met, and this failure to raise has persisted in contemporary Uyghur.

The progressive suffix /-wat/ and the suffix /-wær/ do not trigger vowel reduction in vowel-final roots. /-wær/ indicates that the subject is doing something in spite of some difficulty: e.g., [oquwærdi] 'She kept studying (in spite of some difficulty)'.

(24) *Failure of /-wat/ to trigger vowel reduction in vowel-final verb roots*

/aŋla-wat-i-du/	→	[aŋla-wat-i-du]	'listen-WAT-NONPAST-3'
/talla-wat-i-du/	→	[talla-wat-i-du]	'choose-WAT-NONPAST-3'
/søzlæ-wat-i-du/	→	[søzlæ-wat-i-du]	'speak-WAT-NONPAST-3'
/tjæklæ-wat-i-du/	→	[tjæklæ-wat-i-du]	'forbid-WAT-NONPAST-3'

cf.

/aŋla-GAn/	→	[aŋli-ɣan]	'listen-PERF'
/talla-GAn/	→	[talli-ɣan]	'choose-PERF'
/søzlæ-GAn/	→	[søzli-gæn]	'speak-PERF'
/tjæklæ-GAn/	→	[tjækli-gæn]	'forbid-PERF'

(26) *Failure of /-wær-/ to trigger vowel reduction in vowel-final verb roots*

/hæjdæ-wær-di/	→	[hæjdæ-wær-di]	'drive-WER-3.PAST'
/aŋla-wær-di/	→	[aŋla-wær-di]	'listen-WER-3.PAST'

The effect of these suffixes on vowel reduction in vowel-final verbs also makes sense when their historical origins are considered. /-wat/ is likely to be a fossilized contraction of the multi-word construction \*/-p jat-/ (Hahn, 1991b). The converbial suffix /-p/ chains related clauses, and the verb root /jat-/ means 'to lie' or 'to settle'. In these forms, the final vowel in the root would occur in a word-final closed syllable, and hence be ineligible for vowel reduction (e.g., the historical form \*[aŋla-p jat-i-du] 'She is listening').<sup>11</sup> /-wær/ is a contraction of a similar converbial construction \*/-A bær-, where /-A/ is a converbial suffix and /bær-/ the verbal root 'to give'. The forms in (26) were realized as \*[hæjdæ bærdi] and \*[aŋla bærdi], with the final vowel in the initial word being ineligible for vowel reduction. In both cases, the behavior of the historical form is maintained, despite it violating general synchronic phonotactic restrictions. A recurring pattern we have seen throughout this paper is that suffixes like /-wat/ which are derived historically from multi-word expressions tend to be exceptional with respect to many phonological processes.

Another pair of similar contractions, however, does not display this idiosyncratic failure to trigger vowel reduction. These are /-wæt/ and /-wal/. /-wæt/ indicates that an action happened quickly or suddenly, and may be derived from historical \*/-p at/, where /at/ is the verbal root meaning 'throw' (Tömür, 2003: 420; Abdulla et al. 2010: 1867). /-wal/ is derived from /-p al/, where the verb root /al/ means 'to take' and which expresses a subject doing something for their own benefit. Unlike /-wat/, /-wær/, and /-wæt/, this

<sup>11</sup> cf. Kazakh /oqI-p zatIr-mIn/ → [oqop zaturmun] 'I am reading/studying'.

may be produced in uncontracted form: e.g., [oqup aldi] or [oquwaldi] ‘She studied (for her own benefit)’.<sup>12</sup>

Unlike /-wat/ and /-wær/, however, the final vowel raises before /-wæt/ and /-wal/. Note in particular that the verb-final vowel only raises in the contracted /-wal/ form: the same vowel in the uncontracted /-p al-/ construction does not raise because it occurs in a word-final, closed syllable.

- (25) *Idiosyncratic vowel reduction in /-wæt/ contractions*
- |                |   |                            |                    |
|----------------|---|----------------------------|--------------------|
| /hæjdæ-wæt-Di/ | → | [hæjdiwætti]/*[hæjdæwætti] | ‘drive-WET-3.PAST’ |
| /aŋla-wæt-Di/  | → | [aŋliwætti]/*[aŋlawætti]   |                    |
- (26) *Idiosyncratic vowel reduction in /-p al-/ contractions*
- |                 |   |                            |                         |
|-----------------|---|----------------------------|-------------------------|
| /hæjdæ-p al-Di/ | → | [hæjdæp aldi]              | ‘drive-IP take-3.PAST’  |
|                 | → | [hæjdiwaldi]/*[hæjdæwaldi] |                         |
| /aŋla-p al-Di/  | → | [aŋlap aldi]               | ‘listen-IP take-3.PAST’ |
|                 | → | [aŋliwaldi]/*[aŋlawaldi]   |                         |

For additional discussion of these suffixes, see Fiddler (2021).<sup>13</sup>

## 4.2 Umlaut or regressive assimilation

The second raising process is traditionally referred to as *umlaut* or *regressive assimilation*. This process raises the low vowels /a æ/ to [e] in initial open syllables when the vowel in the following syllable is [i] or [æ].<sup>14</sup>

- (27) */a/ umlaut*
- |        |                   |        |              |
|--------|-------------------|--------|--------------|
| jan    | ‘side’            | jen-i  | ‘side-3.POS’ |
| baʃ    | ‘head’            | beʃ-i  | ‘head-3.POS’ |
| bar-di | ‘go-3.SG.PAST’    | ber-ij | ‘go-GER’     |
| jaz-di | ‘write-3.SG.PAST’ | jez-ij | ‘write-GER’  |

<sup>12</sup> Note that there is another construction /-p bær-, which expresses doing something for another’s benefit. This cannot be contracted.

<sup>13</sup> There is some uncertainty about the etymology of several of these suffixes. /-wæt/ is sometimes claimed to derive from the verb /æt/ ‘to do, make’ (Tömür, 2003: 420), while Nadzhip (1971) suggests that it is derived from the verb /æwæt-/ ‘to send’. Johanson (2004) suggests /-wær/ is derived from the verb /jibær/, which also means ‘to send’.

<sup>14</sup> The relatively restricted distribution of [e] makes it difficult to create contexts where it could trigger umlauting, and hence it is unclear whether it is also a trigger. Yakup (2005:64) and Abdurehim (2014:82) describe umlaut of the mid rounded vowels in the Turpan and Lopnor dialects, e.g., /söz-i/ → [syzi] ‘word-3.POS’. Abdurehim notes that only younger speakers in Lopnor exhibit this pattern, which he implies is borrowed from the standard variety. This argument is supported by Yakup (2005:64) as well, who reports that umlaut of /ø o/ often occurs in the spoken standard variety.

(28) /æ/ umlaut

tæn	‘body’	ten-i	‘body-3.POS’
χæt	‘letter’	χet-i	‘letter-3.POS’
bær-di	‘give-3.SG.PAST’	ber-ijf	‘give-GER’
kæs-ti	‘cut-3.SG.PAST’	kes-ijf	‘cut-GER’

Reduced vowels do not serve as triggers for umlaut.

(29) *Failure of reduced vowels to trigger umlaut*

bala	‘child’	bali-ni/*beli-ni	‘child-ACC’
apa	‘mom’	api-si/*epi-si	‘mom-3.POS’
ætæ	‘tomorrow’	æti-din/*eti-din	‘morning-ABL’
æləm	‘anger’	ælim-i/*elim-i	‘anger-3.POS’

The vowel [æ] also triggers umlaut when present in suffixes (this raises the question of whether regressive assimilation is really an appropriate term for this process).

(30) *Umlaut triggered by [æ]*

/jæ-mAK/	→	[je-mæk]/*[jæ-mæk]	‘eat-INF’
/dæ-mAK/	→	[de-mæk]/*[dæ-mæk]	‘say-INF’
/bær-Aj/	→	[ber-æj]/*[bær-æj]	‘give-1.SG.OPT’
/bær-AIA-i-du/	→	[ber-ælə-j-du]/*[bær-ælə-j-du]	‘give-ABIL-NONPAST-3’
/kæl-Aj/	→	[kel-æj]/*[kæl-æj]	‘come-1.SG.OPT’
/kæl-AIA-i-du/	→	[kel-ælə-j-du]/*[kæl-ælə-j-du]	‘come-ABIL-NONPAST-3’
/bær-Am-siz/	→	[beræmsiz]	‘give-NONPAST.Q-2.SG.FML’

*cf.*

/bar-Aj/	→	[bar-aj]/*[ber-aj]	‘go-1.SG.OPT’
/bar-AIA-i-du/	→	[bar-ala-j-du]/*[ber-ala-j-du]	‘go-ABIL-NONPAST-3’
/qal-Aj/	→	[qal-aj]/*[qel-aj]	‘stay-1.SG.OPT’
/qal-AIA-i-du/	→	[qal-ala-j-du]/*[qel-ala-j-du]	‘stay-ABIL-NONPAST-3’
/bar-Am-siz/	→	[baramsiz]	‘go-NONPAST.Q-2.SG.FML’

#### 4.2.1 Lexical exceptions to umlaut

Like vowel reduction, umlaut does not apply exceptionlessly, with /æ/ undergoing it more frequently than /ɑ/.<sup>15</sup>

<sup>15</sup> One can imagine modeling this using \*MAP constraints (Steriade, 2001; Zuraw, 2007; Steriade, 2009; Zuraw, 2013): because the phonetic distance between [ɑ] and [e] is greater than that between [æ] and [e], the latter mapping is penalized less than the former.

- (31) *Exceptions to umlaut with /ɑ/*
- |      |            |        |                  |
|------|------------|--------|------------------|
| san  | ‘number’   | san-i  | ‘number-3.POS’   |
| kar  | ‘business’ | kar-i  | ‘business-3.POS’ |
| dʒaj | ‘place’    | dʒaj-i | ‘place-3.POS’    |

- (32) *Exceptions to umlaut with /æ/*
- |     |              |       |                    |
|-----|--------------|-------|--------------------|
| pær | ‘feather’    | pær-i | ‘feather-3.POS’    |
| tær | ‘complexion’ | tær-i | ‘complexion-3.POS’ |

#### 4.2.2 Morphologically-conditioned exceptions to umlaut

Similarly, there are a number of morphologically conditioned exceptions or extensions to umlaut. The present/future suffix /-i/ triggers umlaut of /æ/, but not /ɑ/.

- (33) *Idiosyncratic behavior of the present/future suffix /-i/*
- |             |   |                          |                    |
|-------------|---|--------------------------|--------------------|
| /bar-i-mæn/ | → | [bar-i-mæn]/*[ber-i-mæn] | ‘go-NONPAST-1SG’   |
| /bær-i-mæn/ | → | [ber-i-mæn]/*[bær-i-mæn] | ‘give-NONPAST-1SG’ |
| /tap-i-du/  | → | [tap-i-du]/*[tep-i-du]   | ‘find-NONPAST-3’   |
| /tæp-i-du/  | → | [tep-i-du]/*[tæp-i-du]   | ‘kick-NONPAST-3’   |

In Chagatay, the direct ancestor of Uyghur, the equivalent to the /-i/ suffix was /-A/ (Bodrogligeti, 2001).<sup>16</sup> Although this suffix has been permanently reduced to /-i/ in Uyghur, its harmonizing behavior is consistent with its former status as /-A/: it triggers umlaut in cases where its historical realization would have been [-æ] (as in [ber-i-mæn], cf. Chagatay \*[bær-æ-dur-mæn]) but fails to trigger it in cases where its historical realization would have been [-ɑ] (as in [bar-i-mæn], cf. Chagatay \*[bar-ɑ-dur-mæn]).

Umlaut also occurs in certain contractions despite these no longer constituting separate words. Recall the contractions described in Section 4.1.2: /-wal/, /-wat/, /-wær/, and /-wæt/. These contractions exhibit umlaut in the same manner as the uncontracted forms, despite occurring word-medially.

- (34) *Word-medial umlaut in contracted forms*
- |              |   |  |  |
|--------------|---|--|--|
| /bar-p al-f/ | → | [ber-ip el-ij]                                 | ‘go-IP take-GER’                               |
|              |   | →  | [ber-iwel-ij] / *[ber-iwil-ij], *[ber-iwal-ij] |
| /bar-wat-f/  | → | [ber-iwet-ij] / *[ber-iwit-ij], *[ber-iwat-ij] | ‘go-WAT-GER’                                   |
| /bar-wær-f/  | → | [ber-iwer-ij] / *[ber-iwir-ij], *[ber-iwær-ij] | ‘go-WER-GER’                                   |
| /bar-wæt-f/  | → | [ber-iwet-f] / *[ber-iwit-ij], *[ber-iwæt-ij]  | ‘go-WET-GER’                                   |

Note that the same idiosyncratic raising behavior imposed by the present/future suffix /-i/ is observed.

<sup>16</sup> In related languages like Kazakh, Kyrgyz, and Uzbek, the non-past suffix remains /-A/ (e.g., Sjoberg, 1963: 111).

(35) *Word-medial umlaut in contracted forms with non-past suffix*

/bar-p al-i-mæn/	→	[ber-ip al-i-mæn]	‘go-IP take-NONPAST-1.SG’
	→	[ber-iwal-i-mæn]	
	→	*[ber-iwil-i-mæn], *[ber-iwel-i-mæn]	
/bar-wat-i-mæn/	→	[ber-iwat-i-mæn]	‘go-WAT-NONPAST-1.SG’
	→	*[ber-iwit-i-mæn], *[ber-iwat-i-mæn]	
/bar-wær-i-mæn/	→	[ber-iwer-i-mæn]	‘go-WER-NONPAST-1.SG’
	→	*[ber-iwir-i-mæn], *[ber-iwær-i-mæn]	
/bar-wæt-i-mæn/	→	[ber-iwet-i-mæn]	‘go-WET-NONPAST-1.SG’
	→	*[ber-iwit-i-mæn], *[ber-iwæt-i-mæn]	

There’s an interesting discrepancy to be observed here between the behavior of umlaut on these forms and the behavior of vowel reduction described in Section 4.1.2. /-wat/ and /-wær/ behave like the uncontracted historical forms with respect to both vowel reduction and umlaut (in that they fail to trigger reduction in the preceding vowel and undergo umlaut despite being word-medial), while /-wal/ and /-wæt/ behave like the uncontracted forms with respect to umlaut, but not vowel reduction (in that they trigger reduction in the preceding vowel).

### 4.3 Theoretical relevance of vowel raising processes

Both vowel reduction and umlaut have been less carefully studied from a theoretical perspective than vowel harmony. Preliminary analyses of vowel reduction are presented in McCollum (2019) and Mayer (2021, Appendix E). To our knowledge, there has been no phonological analysis of umlaut to date. Identifying the precise factors that contribute to the vowel raising processes will provide additional insight into the realization of stress/vowel length in Uyghur, since these processes are both sensitive to these properties. As well, both vowel reduction and umlaut display similar idiosyncrasies that are (at least partially) predictable based on diachronic factors. As discussed for backness harmony above, these phenomena provide useful test cases for what aspects of the learning data are incorporated into speakers’ synchronic grammars, and how exceptionality is represented.

## 5 Interactions between vowel raising and harmony

The two vowel raising processes interact with both the backness and rounding harmony systems. This section will outline these interactions and some of their theoretical implications.

### 5.1 Vowel reduction and backness harmony

Both vowel reduction and umlauting have the potential to introduce opacity into the backness harmony system, because they neutralize a contrast between the two harmonizing vowels /a/ and /æ/ to the surface transparent vowels [i] or [e]. For example, a root like /apæt/ ‘disaster’ would be expected to take front suffixes because it ends in a front vowel, and indeed it does in forms like [apæt-lær] ‘disaster-PL’. What is perhaps more surprising is that it also takes front suffixes in forms like [apit-i-gæ] ‘disaster-3.POS-DAT’, even though on the surface this appears to violate the harmony patterns described earlier in the paper (cf. forms like [pakit-qa] ‘fact-DAT’).

Vaux (2000) suggested on the basis of a small number of data points that raised tokens of /æ/ exhibit opaque harmony (that is, harmony with the underlying form of the vowel) while raised tokens of /ɑ/ exhibit surface-true harmony (that is, harmony with the surface form). Mayer (2021, submitted) shows on the basis of additional elicitation that patterns of opacity are more complex: although opaque harmony is the most common pattern, there is some variability. Some roots like /ʃæjtɑn/ ‘devil’ display consistent opaque harmony, as in [ʃæjtin-i-ɤɑ] ‘devil-3.POS-DAT’, while other roots like /æʀzɑn/ ‘cheap’ and /æzɑn/ ‘call to prayer’ show variability in whether they display opaque or surface-true harmony.

(36) *Variable opacity in the harmony system*

/æʀzɑn-i-GA/	→	[æʀzin-i-gæ]/[æʀzin-i-ɤɑ]	‘cheap (one)-3.POS-DAT’
/æzɑn-i-GA/	→	[æzin-i-ɤɑ]/[æzin-i-gæ]	‘call to prayer-3.POS-DAT’

Mayer also notes a connection between root frequency and rates of opacity in a large written corpus of Uyghur: although opaque harmony is the norm, less frequent roots show a greater tendency to display surface harmony. Mayer interprets this link between frequency and opacity as evidence that opaque harmony is represented as a type of lexical exceptionality to general harmony patterns (for the relationship between frequency and exceptionality, see, e.g., Bybee, 1985; Morgan and Levy, 2016; for the relationship between opacity and exceptionality, see, e.g., Lubowicz 2003, Mielke et al. 2003, Sanders 2003).

## 5.2 Umlaut and backness harmony

The interaction between umlaut and backness harmony has not been explored in as much detail as the interaction between vowel reduction and backness harmony, but opaque harmony tends to be the rule.

(37) *Opaque harmony in unlauded forms*

jan-ɤɑ	‘side-DAT’	jen-i-ɤɑ	‘side-3.POS-DAT’
bar-ɤɑn	‘go-PERF’	ber-ij-qɑn	‘go-GER-DAT’
tæn-gæ	‘body-DAT’	ten-i-gæ	‘body-3.POS-DAT’
bæʀ-gæʀ	‘give-PERF’	ber-ij-kæ	‘give-GER-DAT’

Some roots have undergone “permanent” umlauting and no longer contain any harmonizing vowels in *any* surface realization (though some still contain harmonizing dorsals). These roots generally harmonize as their historical non-raised forms would have, although this is not always the case (Abdulla et al., 2010).

(38) *Permanently raised roots with historically-consistent harmony*

Modern form	Gloss	Historical form
beliq-ta	‘fish-LOC’	baliq
etiz-da	‘field-LOC’	atiz
hekim-dæ	‘governor-LOC’	hækim
ʃehit-tæ	‘martyr-LOC’	ʃæhit

(39) *Permanently raised roots with historically-divergent harmony*

Modern form	Gloss	Historical form
peqir-da	‘I (humble)-LOC’	pæqir
deñiz-da	‘ocean-LOC’	dæñiz
zemin-lar	‘land-PL’	zæmin
semiz-lar	‘fat-PL’	sæmiz

Note that the forms that differ in harmony from the original value of the raised vowel all involve the raising of /æ/. This aligns with the general tendency towards back suffix forms as a default.

### 5.3 Vowel reduction and rounding harmony

Because vowel reduction maps the low vowels /a æ/ to the high vowel [i], it has the potential to feed rounding harmony, which applies only to high vowels in Standard Uyghur. We have come across cases where vowel reduction feeds rounding harmony, and others where it does not (see also Yakup 2005:66; Abdurehim 2014:77-78). While the verbalizer suffix /-lA/ never undergoes rounding harmony as a byproduct of vowel reduction (40), underlying low vowels in nominal roots often do, as in (41).

(40) *Vowel reduction failing to feed rounding harmony*

/søz-lA-di/	→	[søzlidi]	‘word-VERBAL-3.PAST’
/køz-lA-di/	→	[køzlidi]	‘eye-VERBAL-3.PAST’
/øj-lA-di/	→	[øjlidi]	‘thought-VERBAL-3.PAST’

(41) *Vowel reduction optionally feeding rounding harmony*

/χorma-lAr/	→	[χormular]/[χormilar]	‘persimmon-PL’
/ʃoqqa-lAr/	→	[ʃoqqular]/[ʃoqqilar]	‘peak-PL’
/ʃoqqa-lAr-i/	→	[ʃoqquluri]/[ʃoqquliri]/[ʃoqqiliri]	‘peak-PL-3.POS’
/øʃkæ-lAr/	→	[øʃkylær]/[øʃkilær]	‘goat-PL’
/øʃkæ-lAr-i/	→	[øʃkylyri]/[øʃkyliri]/[øʃkiliri]	‘goat-PL-3.POS’

The interactions between the vowel raising and harmony processes are particularly interesting in light of their apparent variability: although vowel reduction typically results in opaque harmony, this is not always the case; similarly, though vowel reduction feeds rounding harmony in some cases, it does not in others. A better understanding of these phenomena will provide additional insight into how opaque interactions are learned and represented in speakers’ productive phonological grammars.

## 6 Vowel devoicing

We briefly note another pervasive phonological process in Uyghur: vowel devoicing. Descriptions of this process vary to some extent across sources, but the general pattern is that the high vowels /i u y/ may devoice when they occur between two voiceless consonants (including glottal stops, which systematically precede word-initial vowels; Hahn 1991b, Fiddler 2019, ms.). Some examples are shown below:

- (42) /tʃi/ → [tʃi] ‘tooth’  
 /ikki/ → [ʔikki] ‘two’  
 /tyk-i/ → [tyki] ‘fur-3.POS’

Vowels in these contexts devoice most consistently when they occur in non-final syllables, but we note anecdotally that devoicing in monosyllabic words such as [tʃi] ‘tooth’ or [piti] ‘louse’ is also quite common.

There have been limited phonetic studies of vowel devoicing. Tursun and Hemdulla (2010) perform phonetic measurements on voiceless vowels, but this study suffers from a number of methodological issues. Fiddler (2019, ms.) argues based on durational similarities between voiced and devoiced contexts that these vowels are indeed devoiced, and not deleted. He also notes that these vowels are typically produced with some degree of frication by virtue of their close constriction, particularly when adjacent to voiceless fricatives. Fiddler (ms.) also investigates the interaction between vowel devoicing and the other phonological processes described above. He finds that while some of these processes, such as voicing assimilation or vowel reduction, create environments that allow devoicing to apply, the presence of devoicing does not impact the application of these patterns. Fiddler therefore argues that vowel devoicing is a post-lexical phonological process.

## 7 Conclusion

This article presents an overview of several major phonological phenomena in Uyghur and research that has been done on them to date. We hope that this article has highlighted a number of areas that are worthy of future attention and have the potential to provide important theoretical insights. In particular, many of the complexities of Uyghur phonology can be best understood from a historical perspective: the merger of \*/i/ and \*/u/ giving rise to transparent vowels, neutral roots, and consonant harmony triggers; vowel raising processes introducing opacity into the harmony system; exceptionality in particular morphemes relating to their historical forms; and so on.

There are various ways to account for these historical changes in the synchronic grammar. On one hand, numerous previous analyses account for this data by using serial derivations that mirror the diachronic trajectory of change. Lindblad (1990) and Hahn (1991b) provide one such example, accounting for the behavior of neutral roots by assuming an underlying contrast between /i/ and /u/ that is neutralized on the surface. Such analyses make the strong claim that speakers converge on synchronic grammars that effectively recapitulate the diachronic steps that led to the modern Uyghur phonological system. Alternatively, it is possible that learners converge on generalizations that are compatible with the data but differ from the diachronic processes that gave rise to them. In particular, if the historical changes that gave rise to these patterns are generally markedness driven, then an analysis is possible without recourse to derivational levels or a synchronic recapitulation of historical sound changes. We believe that there is much insight to be gained by testing these approaches experimentally (for example, by conducting further wug tests to investigate the extent to which speakers generalize patterns in the attested data), and by exploring the capacity of serial vs. parallel models to account for the attested data as well as future experimental results.

Finally, although we focus on segmental phonology here, we note that there have been a number of theoretical contributions to other topics in Uyghur, such as intonational phonology (Major and Mayer 2018, to appear), the syntax and semantics of indexical shift (Shklovsky and Sudo, 2014; Major and Mayer, 2019; Major, to appear), embedded clauses and complementation (Sugar, 2019; Major, 2021; Major, resubmitted), and auxiliary verbs (McKenzie et al., 2015).

## References

- Abdulla, A., Ebeydulla, Y., & Raxman, A. (2010). *Hazirqi zaman uyghur tili [Modern Uyghur]*. Ürümchi: Xinjiang Xelq Neshriyati [Xinjiang People's Publishing House].
- Abudushalamu, X., Hullebus, & M., Boll-Avetisyan, N. (2020) Uyghur speakers' knowledge of vowel and vowel-consonant harmony. *LabPhon* 2020.
- Abdurehim, E. (2014). *The Lopnor Dialect of Uyghur: A Descriptive Analysis*. (Unpublished doctoral dissertation). Publications of the Institute for Asian and African Studies 17. Helsinki: Unigrafia.
- Allen, B., Pulleyblank, D., & Ajíbóyè, O. (2013). Articulatory mapping of Yoruba vowels: An ultrasound study. *Phonology*, 30(2), 183-210.
- Becker, L. (2016). Vowel-consonant harmony in Uyghur. Unpublished manuscript, Leipzig University.
- Becker, M., Ketrez, N., & Nevins, A. (2011). The surfeit of the stimulus: Analytical biases filter lexical statistics in Turkish laryngeal alternations. *Language*, 87(1), 84–125.
- Bellik, J.A. (2019). *Vowel intrusion in Turkish onset clusters*. (Unpublished doctoral dissertation). University of California, Santa Cruz.
- Bodrogligeti, A. J. E. (2001). *A grammar of Chagatay*. Muenchen, Germany: LINCOM EUROP.
- Bybee, J. (1985). *Morphology: A study of the relationship between meaning and form*. John Benjamins.
- Comrie, B. (1997). Uyghur Phonology. *Phonologies of Asia and Africa*. In. Kaye, A.S. (Ed). Second Edition: 913-925. Eisenbrauns.
- De Jong, F. (2007). *A Grammar of Modern Uyghur*. Utrecht: Houtsmas Stichting.
- Engesæth, T., Yakup, M., & Dwyer, A. (2009/2010). *Teklimakandin salam: hazirqi zaman Uyghur tili qollanmisi / Greetings from the Teklimakan: a handbook of modern Uyghur*. Lawrence: University of Kansas Scholarworks.
- Erdal, M. (2004). *A Grammar of Old Turkic*. Leiden: Brill.

Fiddler, M. (2019). Phonetic characteristics of devoiced vowels in Uyghur. In Calhoun, S., Escudero, P., Tabain, M., and Warren, P. (Eds), *Proceedings of the 19th International Congress of Phonetic Sciences, Melbourne, Australia 2019*. Canberra, Australia: Australasian Speech Science and Technology Association Inc., 1749-1753.

Fiddler, M. (2021). The grammaticalization cline of the Uyghur converb: Syntax, morphology, and prosody. In Özçelik, Ö., and Kent, A.K. (Eds), *Proceedings of the 4th Conference on Central Asian Languages and Linguistics (ConCALL-4)*. Bloomington, IN: Center for Languages of the Central Asian Region, 109-118.

Fiddler, M. (ms.). Vowel devoicing in Uyghur: Phonetics and phonology. University of California, Santa Barbara.

Greenberg, J.H. (1966). *Universals of language*. Cambridge, MA: MIT Press.

Hahn, R. F. (1991a). Diachronic aspects of regular disharmony in modern Uyghur. In W. Boltz & M. Shapiro (Eds.), *Studies in the Historical Phonology of Asian Languages*. John Benjamins.

Hahn, R. F. (1991b). *Spoken Uyghur*. Seattle, WA: University of Washington Press.

Hansson, G. O. (2001). *Theoretical and typological issues in consonant harmony* (Unpublished doctoral dissertation). University of California, Berkeley.

Hayes, B., & Londe, Z. (2006). Stochastic phonological knowledge: the case of Hungarian vowel harmony. *Phonology*, 23, 59–104.

Hayes, B., Zuraw, K., Siptar, P., & Londe, Z. (2009). Natural and unnatural constraints in Hungarian vowel harmony. *Language*, 85, 822–863.

Hockett, C.F. (1955). *A manual of phonology*. Waverly Press.

Hudu, F.A. (2010). *Dagbani tongue-root harmony: A formal account with ultrasound investigation* (Unpublished doctoral dissertation). University of British Columbia.

Heinz, J. (2018). The computational nature of phonological generalizations. In L. Hyman and F. Plank (Eds.), *Phonological Typology*. De Gruyter Mouton, 126-195.

Johanson, L. (1998). The history of Turkic. In L. Johanson and É.Á. Csató (Eds.), *The Turkic Languages*. Routledge.

Johanson, L. (2004). On Turkic transformativizers and nontransformativizers. *Turkic Languages*, 8, 180-190.

- Kaun, A. (2000). Epenthesis-driven harmony in Turkish. *Proceedings of the 25th Annual Meeting of the Berkeley Linguistics Society: Special Session on Caucasian, Dravidian, and Turkic Linguistics*, 95–106.
- Kaun, A. (2004). The typology of rounding harmony. In B. Hayes, R. Kirchner, & D. Steriade (Eds.), *Phonetically based phonology* (pp. 87–116). Cambridge, MA: Cambridge University Press.
- Kimper, W.A. (2011). *Competing triggers: Transparency and opacity in vowel harmony* (Unpublished doctoral dissertation). University of Massachusetts, Amherst.
- Labov, W. (1994). *Principles of linguistic change. Volume 1: Internal factors*. Oxford and Cambridge, MA: Blackwell.
- Lindblad, V. M. (1990). *Neutralization in Uyghur*. University of Washington.
- Lubowicz, A. (2003). *Contrast preservation in phonological mappings* (Unpublished doctoral dissertation). University of Massachusetts, Amherst.
- Major, T. (2021). *On the nature of "say" complementation* (Unpublished doctoral dissertation). University of California, Los Angeles.
- Major, T. (accepted). Revisiting the syntax of monsters in Uyghur. *Linguistic Inquiry*.
- Major, T., & Mayer, C. (2018). Towards a phonological model of Uyghur intonation. In K. Klessa, J. Bachan, A. Wagner, M. Karpiński, and D. Śledziński (Eds). *Proceedings of the 9th Speech Prosody International Conference*. doi: 10.21437/SpeechProsody.2018
- Major, T., & Mayer, C. (2019). What indexical shift sounds like: Uyghur intonation and interpreting speech reports. In M. Baird and J. Pesetsky (Eds). *NELS 49: Proceedings of the Forty-Ninth Annual Meeting of the North East Linguistic Society*, 2, 255-264.
- Major, T., & Mayer, C. (to appear). A phonological model of Uyghur intonation. In Jun, S.-A. and Khan, S.D. (Eds), *Prosodic Typology III*.
- Mayer, C. (2021). *Issues in Uyghur backness harmony: Corpus, experimental, and computational studies* (Unpublished doctoral dissertation). University of California, Los Angeles.
- Mayer, C., & Major, T. (2018). A Challenge for Tier-Based Strict Locality from Uyghur Backness Harmony. In: A. Foret, G. Koble, and S. Pogodalla (Eds.) *Formal Grammar 2018*. Springer, doi: 10.1007/978-3-662-57784-4\_4
- Mayer, C., Major, T., and Yakup, M. (2022). Are neutral roots in Uyghur really neutral? Evaluating a covert phonemic contrast. In P. Jurgec, L. Duncan, E. Elfner, Y. Kang, A. Kochetov, B. O'Neill, A.

Ozburn, K. Rice, N. Sanders, J. Schertz, N. Shaftoe, and L. Sullivan (Eds), *Supplemental Proceedings of the 2021 Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America.

McCollum, A. (2019). Gradient morphophonology: Evidence from Uyghur vowel harmony. In K. Hout, A. Mai, A. McCollum, S. Rose & M. Zaslansky (Eds.), *Proceedings of the 2018 Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America.

McCollum, A. (2020). Sonority-driven stress and vowel reduction in Uyghur. In H. Baek, C. Takahashi & A.H-L. Yeung (Eds.), *Proceedings of the 2019 Annual Meeting on Phonology*. Washington, DC: Linguistic Society of America.

McCollum, A. (2021). Transparency, locality, and contrast in Uyghur backness harmony. *Laboratory Phonology: Journal of the Association for Laboratory Phonology*, 12(1), 10.

McKenzie, A., Eziz, G., and Major, T. (2018). Latent homomorphism and content satisfaction: The double life of Turkic auxiliary –(i)p bol–. *Glossa*, 3(1): 47. doi: <https://doi.org/10.5334/gjgl.422>

Mielke, J., Hume, E., & Armstrong, M. (2003). Looking through opacity. *Theoretical Linguistics*, 29(1-2).

Moore-Cantwell, C. (2018). The interaction of abstraction and idiosyncrasy in learning: introducing the Gradient Lexicon and Phonology Learner. (Invited talk given at the University of Hawai'i at Manoa).

Morgan, E., & Levy, R. (2016). Abstract knowledge versus direct experience in processing of binomial expressions. *Cognition*, 157, 384–402.

Nadzhip, E. (1971). *Modern Uigur*. Moscow: Nauka.

Nazarova, G., & Niyaz, K. (2013). *Uyghur: An elementary textbook*. Washington, DC: Georgetown University Press.

Nazarova, G., & Niyaz, K. (2016). *Uyghur: An intermediate textbook*. Washington, DC: Georgetown University Press.

Nevins, A. (2004). *Conditions on disharmony* (Unpublished doctoral dissertation). Massachusetts Institute of Technology.

Özçelik, Ö. (2015). Stress or intonational prominence? Word accent in Kazakh and Uyghur. *Turkic Languages*, 19, 163–192

Pattillo, K. E. (2013). The typology of Uyghur harmony and consonants. *Rice Working Papers in Linguistics*, 4.

Rose, S., & Walker, R. (2004). A typology of consonant agreement as correspondence. *Language*,

80, 475–531.

Sanders, R.N. (2003). *Opacity and sound change in the Polish lexicon* (Unpublished doctoral dissertation). University of California, Santa Cruz.

Shklovsky, K, and Sudo, Y. (2014). The syntax of monsters. *Linguistic Inquiry*.

Sjoberg, A. (1963). *Uzbek Structural Grammar*. (Uralic and Altaic Series, 18). Bloomington: Indiana University Press.

Steriade, D. (2001). Directional asymmetries in place assimilation: A perceptual account. In E. Hume & K. Johnson (Eds.), *The role of speech perception in phonology* (pp. 219–250). San Diego: Academic Press

Steriade, D. (2009). The phonology of perceptibility effects: The P-map and its consequences for constraint organization. In K. Hanson & S. Inkelas (Eds.), *The nature of the word: Studies in honor of Paul Kiparsky* (pp. 151–179). Cambridge, MA: MIT Press

Sugar, A. (2019). Verb-linking and events in syntax: The case of Uyghur -(i)p constructions. PhD Thesis, University of Washington.

Tömür, H. (2003). *Modern Uyghur Grammar (Morphology)*. Translated by A. Lee. Yildiz Dil ve Edebiyat 3.

Tursun, D., Hemdulla, E. (2010). 维吾尔语中清华元音实验语音学研究. Experimental phonetic study on voiceless vowels in Uyghur. *Journal of Chinese Information Processing*, 117-123.

Yu, A.C. (2007). Understanding near mergers: the case of morphological tone in Cantonese. *Phonology*, 24, 187–214.

Vaux, B. (2000). Disharmony and derived transparency in Uyghur vowel harmony. *Proceedings of NELS 30*, 671-698.

Wolf, M. (2011). Exceptionality. In M. van Oostendorp, C.J. Ewen, E. Hume, and K. Rice (Eds.), *The Blackwell Companion to Phonology, Vol. 4: Phonological Interfaces*. Oxford: Blackwell, pp. 2538-2559

Yakup, A. (2005). *The Turfan Dialect of Uyghur*. Wiesbaden, Germany: Harrassowitz Verlag.

Yakup, M. (2013). *Acoustic correlates of lexical stress in native speakers of Uyghur and L2 learners* (Unpublished doctoral dissertation). University of Kansas.

Yakup, M., and Sereno., J.A. (2016). Acoustic correlates of lexical stress in Uyghur. *Journal of the International Phonetic Association*, doi:10.1017/S0025100315000183.

Zuraw, K. (2007). The role of phonetic knowledge in phonological patterning: Corpus and survey evidence from Tagalog infixation. *Language*, 83, 277–316.

Zuraw, K. (2013). *\*MAP constraints* (Ms.) Los Angeles: University of California, Los Angeles.

Zymet, J. (2014). Distance-based decay in long-distance phonological processes. In *Proceedings of the 32nd West Coast Conference on Formal Linguistics*. Cascadia Press.