Issues in Uyghur Phonology

Connor Mayer (UCI), Adam McCollum (Rutgers), Gülnar Eziz (Harvard)

Abstract

This article presents an overview of several significant aspects of the phonology of Uyghur (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, with particular attention 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 (Engesæth, Yakup, & Dwyer, 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 on its phonology. 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 existing 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 fascinating 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.

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). 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 bolded vowels are those that serve as triggers of backness harmony processes, while the non-bolded vowels are harmonically transparent. The sets of high and low trigger vowels also undergo harmony, while the mid vowel triggers do not.[1] 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 [ɯ] to [ə] to [ɪ] to [i], and Mayer et al. (to appear) demonstrates 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.

	Front		Back	
	Unrounded	Rounded	Unrounded	Rounded
High	i	**y**		**u**
Mid	e	**ø**		**o**
Low	**æ**		**ɑ**	

Table 1: The Uyghur vowel system. Harmonizing vowels are in bold.

---

[1] 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., /gøʃχor/ '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).

In addition to vowels, some consonants also undergo harmonic alternations. The subset of dorsal consonants that participate in the backness harmony system are shown in Table 2. These consonants both trigger and undergo backness harmony.[2]

	Front	Back
Voiceless	k	q
Voiced	g	ʁ

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 ʁ]).
- /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 (see, 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], [-lær]), and the dative suffix /-GA/ (surface forms: [-qɑ], [-ʁɑ], [-kæ], [-gæ]).[3] Voicing alternations in the initial segment are caused by voicing assimilation, and are orthogonal to harmony.

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.

---

[2] Abdulla et al. (2010) suggest that /χ/ 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 /ʁ/. The velar nasal /ŋ/ does not appear to participate in the harmony process, though it does have an allophonic backing effect on adjacent vowels (see, e.g., Mayer et al., to appear).

[3] 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 [χælq-qæ] 'people-DAT' (cf. [χælq-i-gæ] 'people-3.POS-DAT'). We consider this to be a case of 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 Standard 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.

(1)   *Simple front harmonizing forms*
      tyr-dæ/*-dɑ   'type-LOC'
      pæn-lær/*-lɑr   'science-PL'
      munbær-gæ/*-ʁɑ   'podium-DAT'

(2)   *Simple back harmonizing forms*
      pul-ʁɑ/*-gæ   'money-DAT'
      top-qɑ/*-kæ   'ball-DAT'
      ætrɑp-tɑ/*-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*
      mæstʃit-tæ/*-tɑ   'mosque-LOC'
      ymid-lær/*-lɑr   'hope-PL'
      mømin-gæ/*-ʁɑ   'believer-DAT'

(4)   *Back roots with transparent vowels*
      student-lɑr/*-lær   'student-PL'
      uniwersitet-tɑ/*-tæ   'university-LOC'
      ɑmil-ʁɑ/*-gæ   'element-DAT'

Roots with only transparent vowels that contain harmonizing dorsal consonants typically harmonize according to the backness of their dorsals.

(5)   *Roots with only front dorsals*
      kishi-lær/*-lɑr   'person-PL'
      negiz-gæ/*-ʁɑ   'basis-DAT'

(6)   *Roots with only back dorsals*
      qiz-lɑr/*-lær   'girl-PL'
      jiʁin-dɑ/*-dæ   'meeting-LOC'

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.

(7)   *Harmony conflicts between a vowel and a following dorsal*
      mæntiq-qæ/*-qɑ   'logic-DAT'
      æqil-gæ/*-ʁɑ   'intelligence-DAT'
      rɑk-lɑr/*-lær   'cancer-PL'
      pɑkit-lɑr/*-lær   'fact-PL'

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 a small number take front suffixes.

(8)   *Neutral roots that take back suffixes*
        sir-lɑr/*-lær   'secret-PL'
        din-ʁɑ/*-gæ   'religion-DAT'
        hejt-tɑ/*-tæ   'festival-LOC'
        peʔil-lɑr/*-lær   'verb-PL'
        tip-qɑ/*-kæ   'type-DAT'

(9)   *Neutral roots that take front suffixes*
        biz-gæ/*-ʁɑ   'us-DAT'
        bilim-gæ/*-ʁɑ   'knowledge-DAT'
        welsipit-lær/*-lɑr   'bicycle-PL'

2.3   Analyses of transparent vowels

To account for the behavior of transparent vowels, particularly for the idiosyncratic behavior of neutral roots, some researchers have proposed /ɯ/ and /ɤ/ 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 /ɯ/ and /ɤ/ 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 must agree in backness with its vowels), and the behavior of so-called neutral roots is entirely due to the underlying [back] value of their final vowel.

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 /ɯ/ in initial syllables (Lindblad, 1990; Hahn, 1991a, 1991b; Bodrogligeti, 2001; Erdal, 2004).[4] At some point in its history, Uyghur lost the surface distinction between [i] and [ɯ], which complicated the harmony system (at least superficially), introducing transparent vowels, neutral roots, and consonants as harmony triggers.[5] Lindblad (1990) notes that the most frequent roots that previously had /i/ continued to take front suffixes (e.g., /biz/ 'we', /ilim/ 'science', /it͡ʃ-/ 'drink'), the roots that previously had /ɯ/ continued to take back suffixes, and many less frequent roots that were underlyingly /i/ began to take the default back form of suffixes. Uyghur appears to be typologically unusual in that the default harmony value is [+back], despite the fact that transparent vowels are [–back]. In languages such as Mongolian and Finnish, which have similar transparent vowels, transparent roots generally behave as [–back] (Lindblad, 1990).

---

[4] Though see, e.g., Johanson (1998) for a critical perspective.
[5] 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.

Mayer et al. (to appear) proposes an alternative account 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/-/ɯ/ 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 /-lA/ and the infinitival suffix /-mAK/; see Mayer et al. to appear 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., to appear).

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   Lexical exceptionality in backness harmony

In addition to the neutral roots that take front suffixes, a number of roots violate the harmony patterns described above.

First, although roots with only transparent vowels and front dorsals typically take front suffixes, a small number of more recent loanwords display a greater tendency towards back suffixes. These roots do not categorically take back suffixes, but take them more frequently than is typical for such roots.

(10)   *Exceptional front dorsal roots with back suffixes*
        ingliz-lɑr/-lær   'English person-PL'
        etnik-lɑr/-lær   'ethnic group-PL'
        rentigen-ʁɑ/-gæ   'x.ray-DAT'
        gips-qɑ/-kæ   'plaster-DAT'

Second, while suffixes on roots that contain a harmonizing vowel followed by a conflicting harmonizing dorsal typically display agreement with the vowel, 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'
        tæʃwiq-lɑr/*-lær   'publicity-PL'
        tætqiq-lɑr/*-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/-lɑr 'soviet-PL'
        deŋiz sɑhil-i-gæ/-ʁɑ 'ocean shore-3.POS-DAT' (cf. [sɑhil-ʁɑ] 'shore-DAT')

2.5   Morphologically-conditioned exceptions to backness harmony

Suffix-specific exceptionality in Uyghur backness harmony includes suffixes that prefer to harmonize with consonants over vowels, a small set of truly idiosyncratic harmonizers, 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].

(13)   *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 /-wɑt/ (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 /-diʁan/, and most suffixes that mark person and number on verbs.

(14)   *Examples of non-harmonizing suffixes*
        /kyl-wɑt-GAn/   →   [kyl-iwɑt-qɑn]   'laugh-PROG-PERF'
        cf. /kyl-GAn/   →   [kyl-gæn]   'laugh-PERF'

        /rɑjon-lAr-Diki-GA/   →   [rɑjon-lɑr-diki-gæ]   'region-PL-LOC.REL-DAT'
        cf. /rɑjon-lAr-GA/   →   [rɑjon-lɑr-ʁɑ]   'region-PL-DAT'

        /ujʁur-lAr-niŋki-GA/   →   [ujʁur-lɑr-niŋki-gæ] 'Uyghur-PL-GEN.REL-DAT'
        cf. /ujʁur-lAr-GA/   →   [ujʁur-lɑr-ʁɑ]   'Uyghur-PL-DAT'

        /tɑʃ-Dæk/   →   [tɑʃ-tæk]   'stone-SIMIL (stone-like)'
        /køn-i-du/   →   [køn-i-du]   'accept-NONPAST-3'
        /sɑt-i-mæn/   →   [sɑt-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], [-ʁitʃæ], with the initial consonant harmonizing but the final vowel remaining front in all contexts.

(15)   *Examples of partially harmonizing suffixes*
        /ʁuldʒɑ-Gitʃæ/   →   [ʁuldʒɑ-ʁitʃæ]   '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/.

There have been few detailed theoretical treatments of Uyghur backness harmony. 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).

3   Rounding harmony

Uyghur also has a process of rounding harmony that applies only to high vowels. A number of suffixes 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/ or /ø/) the suffix form will contain [y]; if the final harmonizing root vowel is a rounded back vowel (/u/ or /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 /-ʃ/ '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
        /dɑtʃɑ-m/   →   [dɑtʃɑm]   'villa-1Sg.POS'
        /ʁɑz-m/   →   [ʁez-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-wɑt-GAn/ 'laugh-PROG-PERF' generally surfaces as [kyl-iwɑt-qɑn], though [kyl-ywɑt-qɑn] is also possible.[6]

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 some varieties, e.g., the Lopnor dialect, trigger rounding of non-high as well as high vowels, 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 /-lUQ/, which was described above.

(17)   *Examples of rounding harmony on non-epenthetic vowels*
        /qorAl-lUQ/   →   [qorɑl-liq] 'weapon-LIQ (armed)'
        /tæm-lUQ/   →   [tæm-lik]   'taste-LIQ (tasty)'
        /tuz-lUQ/   →   [tuz-luq]   'salt-LIQ (salty)'
        /øz-lUQ/   →   [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).

Hahn (1990b) also describes rounding harmony in epenthetic vowels in loanwords that repair illegal consonant clusters: e.g., [**i**statistika] vs. [g**u**ruppa]. Kaun (2004) points out a similar phenomenon in Turkish, though Bellik (2019) suggests this is the result of phonetic gestural overlap rather than phonological harmony.

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

---

[6] It may be more accurate to consider alternations between [wɑt]~[iwɑt]~[ywɑt] allomorph selection rather than epenthesis, since Uyghur does not usually repair heterosyllabic CC sequences.

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 /ɑ æ/ to [i] in word-medial open syllables. Examples of vowel reduction are shown below.

(18)   */a/ vowel reduction*
bɑlɑ	'child'	bɑli-ni	'child-ACC'
ɑpɑ	'mom'	ɑpi-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*
ɑpæt	'disaster'	ɑpit-i	'disaster-3.POS'
mewæ	'fruit'	mewi-si	'fruit-3.POS'
søzlæ-ʃ	'talk-GER'	søzli-di	'talk-3.SG.PAST'
kyt͡ʃæ-ʃ	'strive-GER'	kyt͡ʃi-di	'strive-3.SG.PAST

This process generally applies only to derived environments. The root /mɑqɑlæ/ 'academic article', for example, surfaces as [mɑqɑlæ] rather than *[mɑqilæ].

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 /ɑ/.

(20)   *Exceptions to vowel reduction with /a/*
hɑwɑ	'weather'	hɑwɑ-si	'weather-3.POS'
dærjɑ	'river'	dærjɑ-si	'river-3.POS'
mɑkɑn	'place'	mɑkɑn-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-iʃ	'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. 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).

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. Vowel reduction only targets light syllables.
3. Initial syllables resist vowel reduction by virtue of positional faithfulness constraints.
4. Primary stress in Uyghur falls by default on the final syllable of a word. This explains why the second syllable in a form like [ɑpɑ] 'mother' does not display vowel reduction but the same syllable in [ɑpi-lɑr] 'mother-PL' does.
5. 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.

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 /-AlA/, do not reduce, while vowels in others, such as the perfective suffix /-GAn/, do.

(22) *Examples of non-reducing suffixes*
jygyr-ælæ-j-du/*jygyr-ilæ-j-du   'run-ABIL-NONPAST-3'
bol-ɑlɑ-j-du/*bol-ilɑ-j-du   'become-ABIL-NONPAST-3'

(23) *Examples of reducing suffixes*
jygyr-gin-i/*jygyr-gæn-i   'run-PERF-3.POS'
bol-ʁin-i/*bol-ʁɑn-i   'become-PERF-3.POS'

/-AlA/ is a grammaticalized contraction of what was once a multi-word phrase. In related Kazakh, abilitative constructions are still multi-word expressions, such as /bɑr-A ɑl-A-mIn/ → [bɑrɑ ɑlɑmʊn] 'I 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 /-wɑt/ and the suffix /-wær/ do not trigger vowel reduction in vowel-final roots. /-waer/ 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*
  /ɑŋlɑ-wɑt-i-du/ → [ɑŋlɑ-wɑt-i-du] 'listen-WAT-NONPAST-3'
  /tɑllɑ-wɑt-i-du/ → [tɑllɑ-wɑt-i-du] 'choose-WAT-NONPAST-3'
  /søzlæ-wɑt-i-du/ → [søzlæ-wɑt-i-du] 'speak-WAT-NONPAST-3'
  /tʃæklæ-wɑt-i-du/ → [tʃæklæ-wɑt-i-du] 'forbid-WAT-NONPAST-3'

  cf.
  /ɑŋlɑ-GAn/ → [ɑŋli-ʁɑn] 'listen-PERF'
  /tɑllɑ-GAn/ → [tɑlli-ʁɑn] 'choose-PERF'
  /søzlæ-GAn/ → [søzli-gæn] 'speak-PERF'
  /tʃæklæ-GAn/ → [tʃækli-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'
  /ɑŋlɑ-wær-di/ → [ɑŋlɑ-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. /-wɑt/ is likely to be a fossilized contraction of the phrase */-p jɑt-/ (Hahn, 1991b). The converbial suffix /-p/ chains related clauses, and the verb root /jɑt-/ 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 *[ɑŋlɑ-p jɑt-i-du] 'She is listening').[7] /-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 *[ɑŋlɑ 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.

Another pair of similar contractions does not display this idiosyncratic failure to trigger vowel reduction. These are /-wæt/ and /-wɑl/. /-wæt/ indicates that an action happened quickly or suddenly, and may be derived from historical */-p ɑt-/, where /ɑt-/ is the verbal root meaning 'throw' (Tömür, 2003: 420; Abdulla et al. 2010: 1867).[8] [-wɑl] is derived from /-p ɑl-/, where the verb root /ɑl-/ means 'to take' and which expresses a subject doing something for their own benefit. Unlike /-wɑt/, /-wær/, and /-wæt/, this may be produced in uncontracted form: e.g., [oqup ɑldi] or [oquwɑldi] 'She studied (for her own benefit)'.[9]

---

[7] cf. Kazakh /ɔqI-p ʒatIr-mIn/ [oqʊp ʒatʊrmʉn] 'I am reading/studying'.
[8] There is some controversy on this point. Nadhip (1971) suggests /-wæt/ is derived from the verb /æwæt-/ 'to send'.
[9] Note that there is another construction /-p bær-/, which expresses doing something for another's benefit. This cannot be contracted.

Unlike /-wɑt/ and /-wær/, however, the final vowel raises before /-wæt/ and /-wɑl/. Note in particular that the verb-final vowel only raises in the contracted /-wɑl/ form: the same vowel in the uncontracted /-p ɑl-/ 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'
/aŋlɑ-wæt-Di/	→	[aŋliwætti]/*[aŋlawætti]	

(26) *Idiosyncratic vowel reduction in /-p Al-/ contractions*

/hæjdæ-p ɑl-Di/	→	[hæjdæp ɑldi]	'drive-IP take-3.PAST'
	→	[hæjdiwaldi]/*[hæjdæwaldi]	
/aŋlɑ-p ɑl-Di/	→	[aŋlap ɑldi]	'listen-IP take-3.PAST'
	→	[aŋliwaldi]/*[aŋlawaldi]	

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 /ɑ æ/ to [e] in initial open syllables when the vowel in the following syllable is [i] or [æ].[10]

(27) */a/ umlaut*

jɑn	'side'	jen-i	'side-3.POS'
bɑʃ	'head'	beʃ-i	'head-3.POS'
bɑr-di	'go-3.SG.PAST'	ber-iʃ	'go-GER'
jɑz-di	'write-3.SG.PAST'	jez-iʃ	'write-GER

(28) */æ/ umlaut*

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

Reduced vowels do not serve as triggers for umlaut.

---

[10] 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., /søz-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.

(29)   *Failure of reduced vowels to trigger umlaut*
       bɑlɑ   'child'   bɑli-ni/*beli-ni   'child-ACC'
       ɑpɑ   'mom'   ɑpi-si/*epi-si   'mom-3.POS'
       ætæ   'tomorrow'   æti-din/*eti-din   'morning-ABL'
       ælæm   '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-AlA-i-du/ →   [ber-ælæ-j-du]/*[bær-ælæ-j-du] 'give-ABIL-NONPAST-3'
       /kæl-Aj/   →   [kel-æj]/*[kæl-æj]   'come-1.SG.OPT'
       /kæl-AlA-i-du/ →   [kel-ælæ-j-du]/*[kæl-ælæ-j-du] 'come-ABIL-NONPAST-3'
       /bær-Am-siz/   →   [beræmsiz]   'give-NONPAST.Q-2.SG.FML'

       cf.
       /bɑr-Aj/   →   [bɑr-ɑj]/*[ber-ɑj]   'go-1.SG.OPT
       /bɑr-AlA-i-du/ →   [bɑr-ɑlɑ-j-du]/*[ber-ɑlɑ-j-du] 'go-ABIL-NONPAST-3'
       /qɑl-Aj/   →   [qɑl-ɑj]/*[qel-ɑj]   'stay-1.SG.OPT'
       /qɑl-AlA-i-du/ →   [qɑl-ɑlɑ-j-du]/*[qel-ɑlɑ-j-du] 'stay-ABIL-NONPAST-3'
       /bɑr-Am-siz/   →   [bɑrɑmsiz]   '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/.[11]

(31)   *Exceptions to umlaut with /ɑ/*
       sɑn   'number'   sɑn-i   'number-3.POS'
       kɑr   'business'   kɑr-i   'business-3.POS'
       dʒɑj   'place'   dʒɑj-i   'place-3.POS'

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

---

[11] 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.

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/*
      /bɑr-i-mæn/   →   [bɑr-i-mæn]/*[ber-i-mæn]   'go-NONPAST-1SG'
      /bær-i-mæn/   →   [ber-i-mæn]/*[bær-i-mæn]   'give-NONPAST-1SG'
      /tɑp-i-du/   →   [tɑp-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).[12] 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 [bɑr-i-mæn], cf. Chagatay *[bɑr-**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: /-wɑl/, /-wɑt/, /-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*
      /bɑr-p ɑl-ʃ/   →   [ber-ip el-iʃ]   'go-IP take-GER'
                →   [ber-iwel-iʃ] / *[ber-iwil-iʃ], *[ber-iwɑl-iʃ]
      /bɑr-wɑt-ʃ/   →   [ber-iwet-iʃ] / *[ber-iwit-iʃ], *[ber-iwɑt-iʃ]   'go-WAT-GER'
      /bɑr-wær-ʃ/   →   [ber-iwer-iʃ] / *[ber-iwir-iʃ], *[ber-iwær-iʃ]   'go-WER-GER'
      /bɑr-wæt-ʃ/   →   [ber-iwet-ʃ] / *[ber-iwit-iʃ], *[ber-iwæt-iʃ]   'go-WET-GER'

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

(35)   *Word-medial umlaut in contracted forms with non-past suffix*
      /bɑr-p ɑl-i-mæn/   →   [ber-ip ɑl-i-mæn]   'go-IP take-NONPAST-1.SG'
                    →   [ber-iwɑl-i-mæn]
                    →   *[ber-iwil-i-mæn], *[ber-iwel-i-mæn]
      /bɑr-wɑt-i-mæn/   →   [ber-iwɑt-i-mæn]   'go-WAT-NONPAST-1.SG'
                    →   *[ber-iwit-i-mæn], *[ber-iwɑt-i-mæn]
      /bɑr-wær-i-mæn/   →   [ber-iwer-i-mæn]   'go-WER-NONPAST-1.SG'
                    →   *[ber-iwir-i-mæn], *[ber-iwær-i-mæn]
      /bɑr-wæt-i-mæn/   →   [ber-iwet-i-mæn]   'go-WET-NONPAST-1.SG'
                    →   *[ber-iwit-i-mæn], *[ber-iwæt-i-mæn]

---

[12] In related languages like Kazakh, Kyrgyz, and Uzbek, the non-past suffix remains /-A/ (e.g., Sjoberg, 1963: 111).

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. /-wɑt/ 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 /-wɑl/ and /-wæt/ behave like the uncontracted forms with respect to umlaut, but not vowel reduction (in that they trigger reduction in the preceding vowel).

To our knowledge, there has been no phonological analysis of umlaut to date.

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 /ɑ/ and /æ/ to the surface transparent vowels [i] or [e]. For example, a root like /ɑpæt/ 'disaster' would be expected to take front suffixes because it ends in a front vowel, and indeed it does in forms like [ɑpæt-lær] 'disaster-PL'. What is perhaps more surprising is that it also takes front suffixes in forms like [ɑpit-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 [fɑkit-qɑ] '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, in prep.) 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-ʁɑ] 'devil-3.POS-DAT', while other roots like /ærzɑn/ 'cheap' and /æzɑn/ 'call to prayer' show variability in whether they display opaque or surface-true harmony.

(36)   *Variable opacity in the harmony system*
        /ærzɑn-i-GA/   →   [ærzin-i-gæ]/[ærzin-i-ʁɑ]   'cheap (one)-3.POS-DAT'
        /æzɑn-i-GA/   →   [æzin-i-ʁɑ]/[æzin-i-gæ]   'call to prayer-3.POS-DAT'

Mayer also notes a connection between root frequency and rates of opacity in a large newspaper 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, rather than a strictly derivational process (for the relationship between frequency and exceptionality, see, e.g., Bybee, 1985; Morgan and Levy, 2016), though experimental evidence is necessary to test this hypothesis.

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 umlauted forms*
jɑn-ʁɑ   'side-DAT'   jen-i-ʁɑ   'side-3.POS-DAT'
bɑr-ʁɑn   'go-PERF'   ber-iʃ-qɑn   'go-GER-DAT'
tæn-gæ   'body-DAT'   ten-i-gæ   'body-3.POS-DAT'
bær-gæn   'give-PERF'   ber-iʃ-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-tɑ	'fish-LOC'	bɑliq
etiz-dɑ	'field-LOC'	ɑtiz
hekim-dæ	'governor-LOC'	hækim
ʃehit-tæ	'martyr-LOC'	ʃæhit

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

Modern form	Gloss	Historical form
peqir-dɑ	'I (humble)-LOC'	pæqir
deŋiz-dɑ	'ocean-LOC'	dæŋiz
zemin-lɑr	'land-PL'	zæmin
semiz-lɑr	'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 /ɑ æ/ to the high vowel [i], it has the potential to feed rounding harmony, as it applies only to high vowels. 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'
/oj-lA-di/   →   [ojlidi]   'thought-VERBAL-3.PAST'

(41)   *Vowel reduction optionally feeding rounding harmony*
        /χormɑ-lAr/   →   [χormulɑr]/[χormilɑr]   'persimmon-PL'

        /ʧoqqɑ-lAr/   →   [ʧoqqulɑr]/[ʧoqqilɑr]   'peak-PL'
        /ʧoqqɑ-lAr-i/   →   [ʧoqquluri]/[ʧoqquliri]/[ʧoqqiliri]   'peak-PL-3.POS'

        /øʧkæ-lAr/   →   [øʧkylær]/[øʧkilær]   'goat-PL'
        /øʧkæ-lAr-i/   →   [øʧkylyri]/[øʧkyliri]/[øʧkiliri]   'goat-PL-3.POS'

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). Some examples are shown below:

(42)   /tʃiʃ/   →   [tʃi̥ʃ]   'tooth'
        /ikki/   →   [ʔi̥kki]   'two'
        /tyk-i/   →   [tyki̥]   'fur-3.POS'

Vowels in these contexts devoice most consistently when they occur in unstressed syllables (Hahn 1991, Fiddler 2019), but we note anecdotally that devoicing in monosyllabic words such as [tʃi̥ʃ] 'tooth' or [pi̥t] '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 severe methodological issues. Fiddler (2019) presents acoustic evidence that vowels are indeed devoiced, and not deleted, in these contexts. 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.

To our knowledge there has been no careful investigation of the interaction between vowel devoicing and other aspects of the phonology of Uyghur.

7   Conclusion

This article presents an overview of several major phonological phenomena in Uyghur and research that has been done on them to date. Uyghur is a language with a rich and fascinating phonological system, and 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 */ɯ/ 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 /ɯ/ 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 only accidentally reflect many (not all) historical changes in the language. 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, 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].

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.

Becker, L. (2016). Vowel-consonant harmony in Uyghur. Unpublished manuscript, Leipzig University.

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: Houtsma 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.

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.

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.

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.

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. Kobele, and S. Pogodalla (Eds.) *Formal Grammar 2018*. Springer, doi: 10.1007/978-3-662-57784-4_4

Mayer, C., Major, T., and Yaku,p M. (to appear). 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 –(İ)p bol–. *Glossa, 3*(1): 47. doi: https://doi.org/10.5334/gjgl.422

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.

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.

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.