Labial Harmonic Shift in Kazakh: Mapping the Pathways and Motivations for Decay

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1   Introduction

Despite the amount of ink spilt on vowel harmony there is surprisingly little written about the decay of harmony systems (Greenberg 1990; Binnick 1991; Nevins & Vaux 2003; Svantesson 2005; Kavitskaya 2013; see also McPherson & Hayes forthcoming).[1] While a number of authors have suggested possible pathways for harmonogenesis (Ohala 1994; Harrison et al. 2002) the motivations for harmonic decomposition remain largely unclear. Using data collected during recent fieldwork, this paper addresses the nature of harmonic decay through an acoustic analysis of labial harmony in Kazakh. In contemporary Kazakh, the domain for labial harmony is typically the root, and post-initially rounding has largely been neutralized, in contrast to previous descriptions of the language. The drastic reduction in labial harmony between previous studies and the present work is used to conceptualize harmonic decay along two lines: domain contraction, and neutralization.[2] Additionally, the role of markedness is addressed as it relates to the specific trajectory of change in the language.

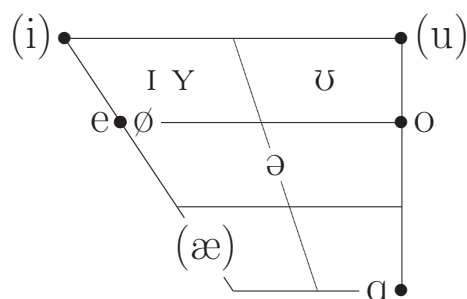## 2   Labial Harmony in Kazakh

2.1   Vowel Inventory

Kazakh scholars have debated the number of underlying vowels in the language generally arguing for nine, or ten underling vowels (Dzhunisbekov 1972:10-11; Sharipbay 2013; Yessenbayev et al. 2012 and citations therein). I will work on the assumption that there are actually eleven underlying vowels in the language, eight harmonic vowels plus three additional vowels. The details of the three additional vowels, /i/, /u/, and /æ/ are of less importance, and consequently, their role in harmony will not be addressed. The other eight vowels are

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[1]The following abbreviations are used throughout the paper: 2- second person, 3- third person, ACC- accusative, CAB- converb, GER- gerundial, LOC-locative, NPST- non-past, PASS- passive, PL- plural, PST- past, PTCP- participle, and REFL- reflexive.

[2]The assimilatory force of active harmony is often describe as neutralizing in nature because the quality of harmonic vowels becomes predictable and constrained by the harmonic feature of the root. In a Turkic language with a fully functioning harmony system, like Kyrgyz, eight post-initial vowels may surface, but in a language with reduced labial harmony, like Kazakh, the number of post-initial vowels that may surface is reduced to 6, with restrictions on 2 of those 6. In this way post-initial vowel quality is constrained by the loss of harmony. For this reason, I use the term neutralization throughout the paper.

distinguished by the features: [high], [back], and [round]. Of note, [ə] is treated as a [+high] vowel in Kazakh (Johanson 1998:93-94).

2.2 Labial Harmony

Kazakh exhibits two types of harmony: palatal (backness), and labial (rounding) harmony. These two interacting harmonies determine the quality of vowels post-initially, whether root-internal or suffixal.[3] Palatal harmony is pervasive in the language. However, rounding harmony is far more restricted, affecting only a subset of potential targets. Menges (1947:59-62) and Korn (1969:101-102) note that front vowels condition the rounding of all subsequent harmonic vowels, and back vowels trigger rounding only if the target is high. These same generalizations persist throughout much of the Soviet and post-Soviet literature on Kazakh (e.g. Abuov 1994), as shown below.

(1)

tøbø-lør	'hill-PL'	*ʒebe-ler*	'arrow-PL'
øt-tʏ-ŋ-dør	'pass-PST 2-PL'	*jet-tɪ-ŋ-der*	'do-PST-2-PL'
kʏn-dør	'day-PL'	*dɪn-der*	'religion-PL'
kʏl-dʏ	'laugh-PST.3'	*ɪl-dɪ*	'hang-PST.3'
qʊs-ta **qʊs-to*	'bird-LOC'	*qəs-ta*	'winter-LOC'
qʊs-tʊ	'bird-ACC'	*qəs-tə*	'winter-ACC'
qozʊ-ɫar-də **qozʊ-ɫor-dʊ*	'lamb-PL-ACC'	*qazə-ɫar-də*	'horse sausages-PL-ACC'

More recent works have adopted the same general analysis with several important restrictions on harmony: one, harmony affects high vowels more significantly than non-high vowels,

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[3]Following Vajda (1994) and Harrison & Kaun (2000), I will assume throughout this paper that root-internal vowels are potential targets for harmony and not lexicalized to their current forms.

and two, harmonic effect diminishes as distance from the root increases. Kirchner observes that while both high and non-high targets are affected by rounding harmony the general strength of rounding is lesser in syllables further from the root. Additionally, he observes that this reduction in rounding is more acute for non-high vowels (1998:320-321). Vajda argues similarly, adding that root-internal vowels are more likely targets for harmony than suffix vowels (1994:634). Even more recently, Kara writes that in western Kazakh dialects labialization affects only the second vowel of a word while in eastern Kazakh dialects all subsequent vowels are affected (2002:12). Contraction of the harmonic domain has been noted for dialects of Crimean Tatar (Kavitskaya 2010:26-27, 2013), Karakalpak (Menges 1947:60), and outside the Turkic family, as well (McPherson and Hayes forthcoming).

Previous studies of Kazakh, if viewed longitudinally, display a diminution in labialization post-initially. While these writers note thatfirst-syllable vowels demonstrate the full range of vowel qualities present in the Kazakh inventory, neutralization to [-round] vowels post-initially is suggested, but not specifically analyzed. This paper examines the acoustic correlates of post-initial rounding, arguing for the continued decay of labial harmony in the language.

3   Methods

3.1   Participants

Eleven native Kazakh speakers (8 females, 3 males; age range = 19-46 years, mean age = 33.5 years) living in or around Taldykorgan (the capital of the Almaty Oblast in southeastern Kazakhstan) participated in conversational elicitation of nominal and verbal paradigms. Most speakers were from the Almaty Oblast, but speakers from South Kazakhstan and Aqmola Oblasts, as well as from western Mongolia participated in the study. Speakers ranged in educational background from partial high school education to multiple graduate degrees, with most speakers having attained a high school diploma as their highest degree earned. All speakers were fluent in Russian as well as Kazakh, and some speakers were additionally conversant in Mongolian, Chinese, and English. All elicitation was conducted in Kazakh.

3.2   Protocol

Speakers were asked to identify target words from pictures to avoid the influence of Kazakh orthography, which does not indicate post-initial rounding, as well as the influence of literary register. Many Kazakhs comment that Kazakh is rarely used for writing, and languages like Russian and English are more appropriate for such endeavors. This likely stems from the Soviet characterization of indigenous languages as backwards. Those whose primary language was an autochthonous language (i.e. not Russian) were deemed uncultured during the Soviet era (see Grenoble 2003:193-197). Speakers constructed sentences using the following nouns (2) and verbs (3) in a variety of derivational and inflectional forms.

(2) Nouns

øt	'gall bladder'	*jet*	'meat'
tøbe	'hill'	*ʒebe*	'arrow'
kømɤr	'coal'	*temɪr*	'iron'
kɤn	'day/sun'	*dɪn*	'religion'
ʒɤzɤm	'grape'	*tɪzɪm*	'list'
qoj	'sheep'	*saj*	'ravine'
qozʊ	'lamb'	*qazə*	'horse sausage'
qʊs	'bird'	*qəs*	'winter'
qʊɫʊp	'lock'	*aɫəp*	'giant'

(3) Verbs

øl-	'die (of animals)'	*kel-*	'come'
kɤl-	'laugh'	*ɪl-*	'hang (something)'
qʊs-	'vomit'	*qəs-*	'press'
qos-	'add'	*qʊr-*	'build'
søjle-	'speak'	*qʊj-*	'pour'
qasə-	'scratch'		

To control for any foreigner talk or generally unnatural speech, speakers completed a map task derived from the University of Edinburgh's HCRC map corpus (Anderson et al. 1991) where one speaker gave directions to another native speaker. The placement of the landmarks on the map was not uniform, triggering dialogue concerning the route described. These dialogues provided a control scenario to compare with the elicitation scenarios. On the basis of the similarity of labial harmony in the two scenarios, elicited data was deemed representative of colloquial Kazakh speech. Colloquial, as opposed to literary, Kazakh was the intended speech register for elicitation. Kazakh is diglossic, with a literary register that is used in news reporting, poetry and literary recitations and other similar contexts. These differences in register also correspond to differences in harmony, where higher register speech correlates with higher application of vowel harmony in general (McCollum 2015b; see also Abuov 1994). Kazakh speakers report being instructed to produce words with a

literary pronunciation in school, and this tendency is evident in prescriptivist approaches to Kazakh grammar (e.g. Userbayeva 2005). The intent of this study was not to collect higher register speech, but to collect colloquial speech, which prompted the above noted choices in elicitation. All sessions were video and audio recorded. Audio was recorded at a 44.1kHz sampling rate with 24-bit depth.

4   Results

Audio files were analyzed using a modified version of Katherine Crosswhite's formant logger script[4] in PRAAT (Boersma & Weenink 2014). F1-F3 were obtained from three points during post-initial vowel production, 25%, 50%, and 75%. Measurements from the midpoint of each vowel were then normalized (Lobanov 1971) for across-speaker comparison. Normalized vowel data (N= 3,608) was used to assess the amount of post-initial lip rounding in two ways in R (version 3.1.1, R Core Team 2014). First, a quadratic discriminant analysis was performed (using the MASS package, version 7.3-33), where post-initial vowel qualities were discriminated using normalized F1-F2.[5] Second, a mixed effects model (using the lme4 package, version 1.1-7) was used to predict normalized F2 with speaker as a random effect and the following fixed effects: height, root backness, root rounding, distance from root, intervening consonants, and and intervening vowels.

4.1   Discriminant Analysis

A quadratic discriminant analysis was performed on root, as well as target vowels, under the assumption that if rounding persists post-initially, then vowel discrimination in roots and targets should generally be equal. If, however, rounding is diminished post-initially, then accurate vowel discrimination among the eight root vowels analyzed should exceed vowel discrimination among target vowels. The model was resampled using the jack-knife method and F1-F2 were set as the parameters for classification.

Tokens (N=2,490)[6] of the eight root vowels /ɑ o ə ʊ e ø ɪ ʏ/[7] were correctly discriminated 59.4% of the time.[8] In the analysis of monopthongal targets (N=3,259), all vowels after the low back vowel, [ɑ] were excluded because [ɑ] is reported to block harmony in all descriptions of the language. When rounding was assumed to affect every post-initial vowel, resulting in eight potential post-initial categories, the model correctly discriminated 45.1% of vowel tokens. When round vowels were assumed to neutralize across the board (in effect reducing the number of vowel categories to four), discrimination improved to 75.0%.

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[4]This script is available at http://www.linguistics.ucla.edu/faciliti/facilities/acoustic/praat.html

[5]F3 was also used initially, but proved to be an insignificant parameter in the model, and was therefore removed.

[6]Many word-initial vowels were elided due to vowel syncope (see Kavitskaya 2013).

[7]The other three phonemic vowels were excluded, both because they figure far less prominently in the language, and because their occurrence post-initially does not conform to the regular application of harmony. By excluding these vowels, a parallel was established between possible root and target vowel categories that undergirds this portion of the analysis.

[8]As a point of reference, Hillenbrand et al. (1995), achieved 68.2% accuracy discriminating English vowel phonemes based on F1-F2.

The significant increase in discriminatory accuracy when rounding was assumed to neutralize post-initially points toward a very real reduction of rounding harmony. However, vowel discrimination in harmonic languages is less straightforward than in non-harmonic languages like English (e.g. Hillenbrand et al. 1995) because rounding harmony allows pairs of segments that are minimally distinct to surface despite violations of dispersion principles that are argued to affect inventory selection among the world's languages (Lindblom 1986; Flemming 1995). Since a number of weakly distinct pairs are permitted, it is possible that reducing the number of categories, in and of itself, accounts for the drastic increase in discrimination. In essence, an increase in post-initial vowel discrimination is not necessarily grounds for advocating neutralization, but rather may only demonstrate the intrinsic similarity of harmonic pairs. To address this potential confound, root vowels were analyzed using the same reduction of categories from eight to four in order to determine if category reduction, and not actual shifts in vowel realization, precipitated increased accuracy among post-initial vowels. When root vowel categories were collapsed from eight to four, vowel discrimination improved to 65.3%, a 10.1% increase in accuracy. Compared to the 66.2% increase in accuracy among post-initial vowels when categories were reduced (i.e. when neutralization was assumed), the increase in discriminatory accuracy among post-initial vowels does appear to reflect a significant degree of actual neutralization. When Figures 1 and 2 are consulted, a merger of vowel qualities in post-initial contexts is evident.
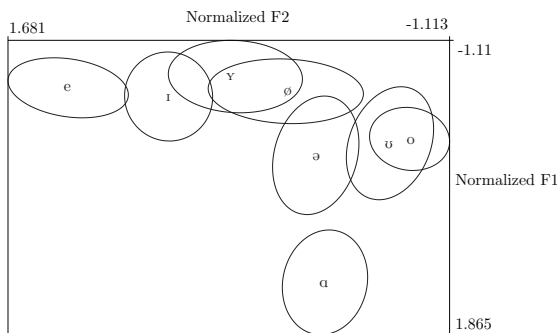

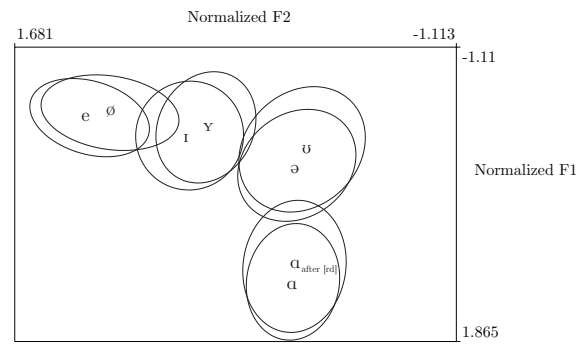Figure 1: Plot of normalized root vowels with 1 sigma ellipses

Figure 2: Plot of normalized post-initial vowels with 1 sigma ellipses

The distribution of root versus post-initial vowels in Figures 1 and 2 is strikingly different, showing the conflation of acoustic vowel qualities suggested by the discriminant analysis. In Figure 2, the vowels labeled as ø, ʏ, and ʊ are labeled according to previous descriptions. When each [±round] pair is considered, a merging of post-initial vowel qualities to [-round] appears appropriate. The quality of the non-high back vowel after a round root, as is predicted by previous accounts (e.g. Korn 1969; Kirchner 1998) overlaps almost entirely with the low back vowel after an unrounded root. The phonologically high back unrounded vowel (phonetically [ə]) is realized with similar F2 but lower F1 than [ɑ] in both roots and targets. In targets, though, the vowel previously recorded as [ʊ] surfaces much more like [ə] than root [ʊ]. Similarly, the centralization of [ø] is apparent in root position, but post-initially the non-high front vowel after round roots is realized with a much higher F2, more closely resembling root and post-initial [e] than root [ø]. The high front vowels show slightly less

merger post-initially, although there is significant overlap in the F1-F2 vowel space. Vowels show a decided reduction in contrast post-initially, with some variance according to backness and height distinctions.

4.2 Mixed Effects Modeling

4.2.1   Overall results

The discriminant analysis performed suggests that rounding of post-initial vowels is neutralized, and although it seems clear that the direction of neutralization is toward [-round], the analysis above doesn't explicitly suggest the direction of neutralization. Furthermore, discriminant analysis predicted categorical vowel qualities based on phonetic information, and while this categorical perspective is immensely helpful, framing the dependent variable as continuous offers a complementary look at the data. To do this, a linear mixed effects model was employed to predict acoustic realization of harmonic vowels based on a variety of categorical predictors. The underlying assumption is that the acoustic difference between [±round] pairs post-initially should reflect the difference between those same pairs in roots. Zsiga (1997:234-235) describes harmonic vowels as identical to their non-harmonically derived root equivalents in Igbo, gradient vowel change derives from phonetic processes. Moreover, Lanfranca (2012) finds that post-initial harmonic vowels in Turkish do approximate their root equivalents, and in some cases, expand the vowel space as a potential enhancement effect. Using the highest and lowest normalized values of F1-F2 plus or minus one standard deviation, a quadrilateral was plotted that roughly approximates the vowel space in roots versus post-initial contexts. The area of each quadrilateral was then determined, which, when compared showed a 27.23% contraction of the vowel space post-initially. Thus, assuming a relatively uniform contraction of the vowel space, if the difference in F2 (ΔF2) of each [±round] pair does not exceed a 27% contraction in post-initial contexts, then rounding persists. If, however, ΔF2 post-initially is significantly smaller (i.e. contraction is far greater than 27% for each pair), then acoustic differences are being diminished, and by extension, rounding is being neutralized.

In both initial and post-initial contexts, ΔF2 for each of the four harmonic pairs is presented in Table 1. The data show a very real decrease in ΔF2 post-initially, corroborating findings from the discriminant analysis.

Table 1. ΔF2 and contraction of the vowel space

[±round] pair	ΔF2 in roots	ΔF2 post-initially	% Reduction of ΔF2 post-initially
ɑ-o	0.529z	0.014z	97.45
ə-ʊ	0.469z	0.071z	84.87
e-ø	1.375z	.129z	90.63
ɪ-ʏ	0.42z	.103z	75.4

The data in Table 1 shows the degree of ΔF2 contraction post-initially for all four contexts. Of note, in addition to the F2 distinctions above, the most salient difference between[ɑ] and [o] is F1. For root vowels, ΔF1 was 1.453z. However, post-initially ΔF1 between [ɑ] and [o] was 0.16z, a 88.99% reduction in ΔF1. If neutralization is framed in terms of percent

ΔF2 contraction or in terms of size of ΔF2 post-initially, two asymmetries emerge: front vowels have resisted neutralization more than back vowels, and high vowels have resisted neutralization more than non-high vowels.

The reduction of normalized F2 as an acoustic correlate of rounding is attested throughout the data. Overall, the effect of root rounding on post-initial vowels (N=3,259, excluding vowels after the non-high back vowel) was -0.082z (SE=0.011, t=-7.13), an effect that when scaled back into Hz reflects a decrease of approximately 40-60 Hz for most speakers. This modulation of F2 does not typically surpass the perceptual threshold for ΔF2 (Flanagan 1955), and is therefore conceivably a phonetic coarticulatory effect. Furthermore, if Zsiga's (1997) criterion that categorical assimilation creates vowels acoustically identical to their root equivalents, then the data in no way reflects an active categorical assimilation process. Harmonic context-specific effects of root rounding are shown in Table 2 below.

Table 2. Acoustic effect of rounding by context

Harmonic context	Sample size	Effect (β) on post-initial F2	Standard error	T-value
non-high back	620	-0.034	0.022	-1.52
high back	736	-0.139	0.028	-4.98
non-high front	847	-0.098	0.020	-4.85
high front	1056	-0.098	0.017	-5.76

Overall, distance from the root was a significant predictor of normalized F2, β=0.101z (SE=0.01, T=8.72). Distance from the root was formulated with root-internal targets being the most proximate, then first suffixes, then second suffixes and so on. As distance from the root increases, so does normalized F2, which suggests that as distance from the root increases, reduction of F2 due to labialization is attenuated. In short, rounding harmony affects morphologically proximate targets more than morphologically distant targets (Vajda 1994:634; Kirchner 1998:320-321). The effect of rounding on root-internal and first suffix vowels is far greater than on second and third suffix vowels. This effect is very similar to what McPherson and Hayes (forthcoming) find in Tommo So- harmony "peters out" over the course of the word. This analysis is framed in terms of gradient phonetic modulations while their analysis of Tommo So hinges upon categorical information, but the underlying idea is the same, as expressed by previous writers of Kazakh: the effect of rounding diminishes throughout the word. In Figures 3-5 and 11-12, root, as well as post-initial vowels are plotted according to harmonic (i.e. backness and height) context and morphological environment.

4.2.2 Back vowels

In Figure 3, the predicted realization of non-high back vowels as [ɑ] and not *[o] after round roots (Korn 1969:101-102) was attested. In Figure 4, the high back vowels show more complex and interesting effects of morphological context. Root-internally, both the vowels predicted to be [ə] and [ʊ] were realized with normalized F2 values between root [ə] and [ʊ]. The lowering of F2 after [ɑ] is surprising, but I attribute this general lowering of F2 in this context to the adjacent [ł] and [p] the in the two roots elicited, *qułʊp* 'lock' and *ałəp* 'giant.'
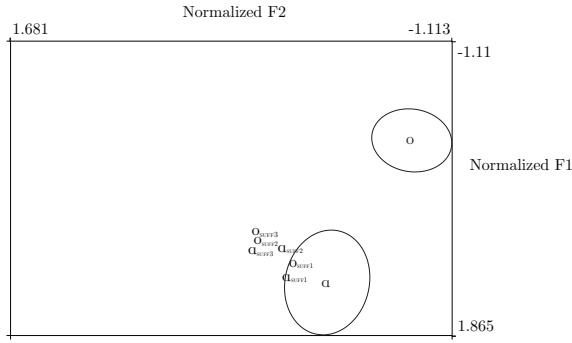
Figure 3: Plot of non-high back vowel roots (with 1 sigma ellipses) compared to post-initial means after [±round] roots
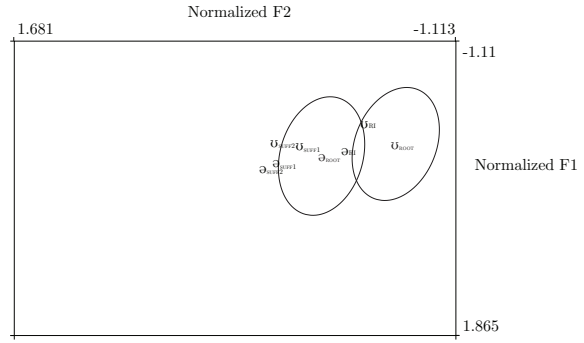
Figure 4: Plot of high back vowel roots (with 1 sigma ellipses) compared to post-initial means after [±round] roots

This is more evident when the second syllable vowels in the two variants, *qʊɫʊp ∼ qʊɫpʊ* 'lock' are compared, in Figure 5. In *qʊɫpʊ*, when the lateral is no longer adjacent to the target vowel, the second syllable vowel is produced with a slightly increased F2.
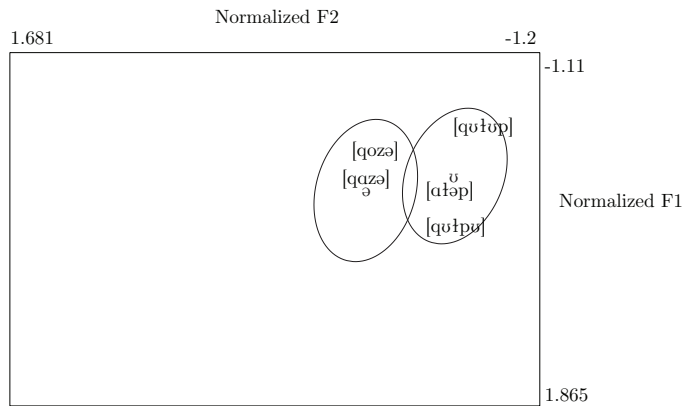

Figure 5: Plot of high back root vowels (with 1 sigma ellipses) compared to root-internal high back vowels by word

Table 3. Acoustic properties of root-internal [+high, +back] vowels by root

Root	Sample size	F1	SD	F2	SD
qɑzə	52	-0.042	0.536	-0.256	0.309
qozə	46	-0.245	0.576	-0.302	0.321
ɑɫəp	35	0.056	0.392	-0.702	0.15
qʊɫpʊ	9	0.345	0.514	-0.702	0.264
qʊɫʊp	37	-0.487	0.369	-0.855	0.295

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Kirchner (1990:56, 1998:319) argues that before the lateral /ɑ/ may be rounded. Phonetic rounding of /ɑ/ in initial syllables is attested in several related languages (e.g. Bashkir-Poppe 1964:8; Tatar- Comrie 1997:900; Harrison & Kaun 2003:204-205). Harrison & Kaun find that in Namangan Tatar the phonetic rounding of /ɑ/ actually triggers rounding harmony. Combined with Kirchner's observations, it is possible that decreased F2 of the second syllable vowel in *aɫəp* derives from a phonetic rounding of the initial vowel. However, no indications of word-initial rounding of /ɑ/ were found during fieldwork. Subsequent inspection of articulation during vowel production further suggests that /ɑ/ is not rounded. Although the second syllable vowel matches the formant frequencies of root-position [ʊ] the lip gesture during production of the vowel is spread, and could be more narrowly transcribed as [ɤ].

Figures 6 and 7 show productions of [ɑɫəp] 'giant' and [qʊɫʊp-tə] 'lock-ACC', respectively by Speaker 2. Figures 8 and 9 show productions of [ɑɫəp-tə] and [qʊɫʊp-tə] from Speaker 7. In Figures 6 and 8, observe the lowered jaw for word-initial [ɑ] but notice that there is no lip rounding. In figures 7 and 9, lip rounding is observable throughout all segments in the root, [qʊɫʊp], but the lips move to a more spread position in suffixes. Speaker 2 rounds her post-initial vowels after round roots slightly more than the group average (β = -0.094, SE=0.028 versus β = -0.082, SE=0.011), but Speaker 7 rounds her vowel more most speakers (β = -0.157, SE=0.028). Even among speakers who round subsequent vowels, like Speaker 7, the rounding gesture is gradually diminished throughout the first suffix vowel, as in Figure 9. When the word-final vowels of Figures 8 and 9 are compared, the vowel in Figure 9 shows more lip rounding than in Figure 8, but less rounding than root-internal vowels in Figure 8. In this particular utterance the slight rounding of the lips in the suffix is due to an anticipatory rounding before the affricate [ʤ] in the sentence, [qʊɫʊptə̣ ʤɑp] 'Close the lock.' The voiced palato-alveolar afficate is produced with slight lip rounding in Kazakh, similar to its articulation in English. When the spectrogram of the utterance is viewed (Figure 10), it is clear that despite some anticipatory lip rounding the word-final vowel in [qʊɫʊptə̣] has a much higher F2 than the root-internal vowels preceding it. In tandem, articulatory and acoustic data provide sufficient evidence for root-internal, but not suffix rounding.
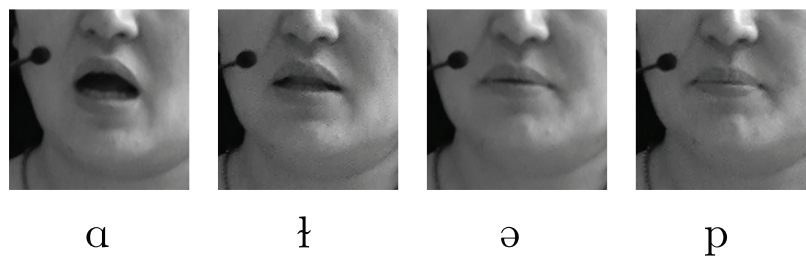

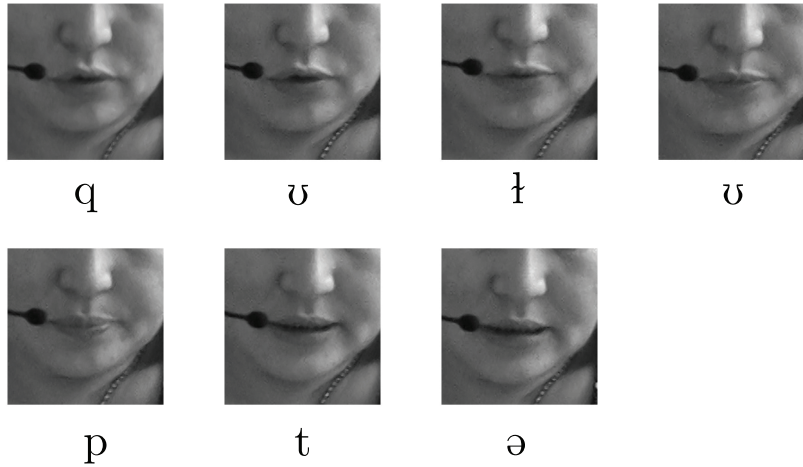Figure 6: Still images of Speaker 2 producing *aɫəp* 'giant'.

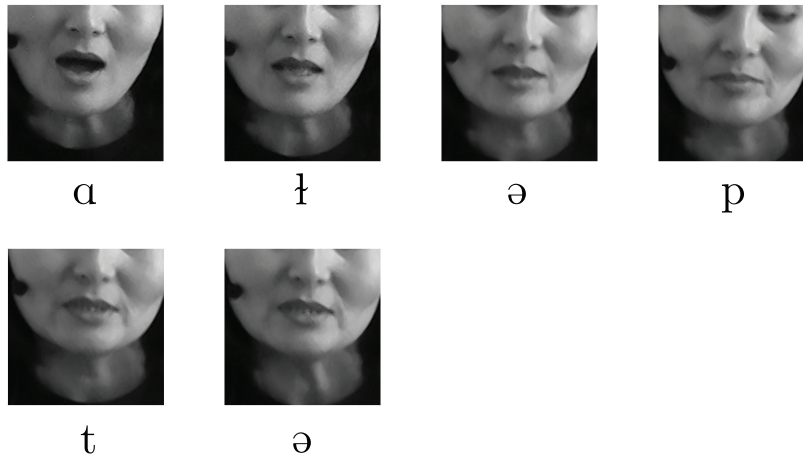Figure 7: Still images of Speaker 2 producing *quɫʊptə* 'lock-ACC'.

Figure 8: Still images of Speaker 2 producing *aɫəp-tə* 'giant-ACC'.

In Figure 5, note the difference between the high vowel in *qozə* 'lamb' and the second syllable high vowel in *quɫpʊ*. In *qozə*, the vowel surfaces as a schwa, with only a minor difference in F2 compared to the high vowel in *qazə* 'horse sausage.' Thus, rounding is affected by the character of the trigger in the [+back] context, where a [+high] vowel triggers post-initial rounding within a root, but a [-high] vowel does not.

4.2.3   Front vowels

As with the non-high back vowel, the non-high front vowel shows very little signs of categorical rounding. The acoustic distance between root [e] and [ø] is so great that the decrease in F2 caused by a round vowel is insufficient to approximate the formant values for initial [ø]. In later affixes, [e] is acoustically more centralized, part of the overall contraction of the vowel space post-initially.
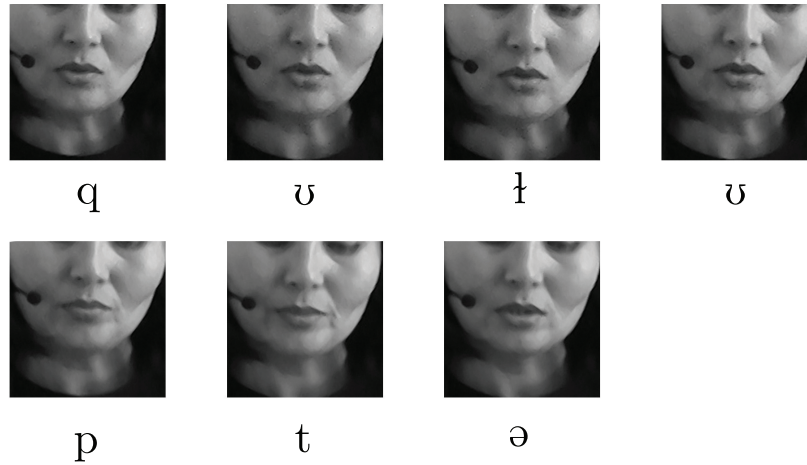
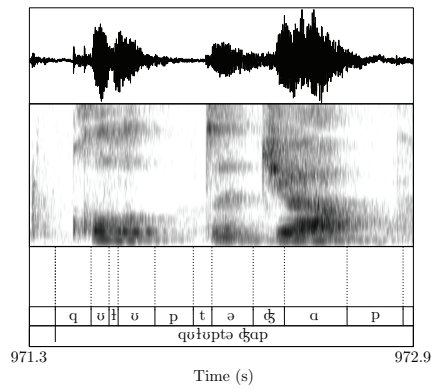Figure 9: Still images of Speaker 7 producing *qʊɫʊp-tə̣* 'lock-ACC'.

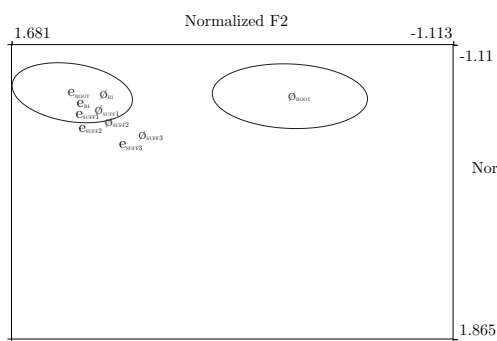Figure 10: Waveform and spectrogram of Speaker 7 producing *qʊɫʊptə̣ ʤap 'Shut the lock.'*

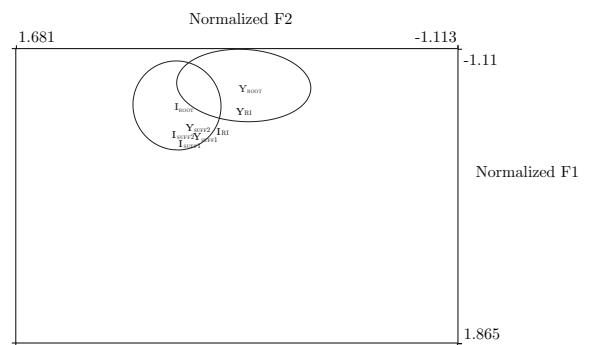Figure 11: Plot of non-high front vowel roots (with 1 sigma ellipses) compared to post-initial means after [±round] roots

Figure 12: Plot of high front vowel roots (with 1 sigma ellipses) compared to post-initial means after [±round] roots

The realization of the high front harmonic vowel tends strongly towards [ɪ] in Figure 11, except root-internally. Within roots like ʒʏzʏm 'grape' and kømʏr 'coal', rounding occurs almost without exception. However, in other contexts lip rounding is rarely observed. Across morpheme boundaries rounding was more frequently attested in words like [kʏn-dʏ] 'day-ACC' or [kʏl-ʏp] 'laugh-CVB.' Continuing the trend of trigger-target dependencies noted above, rounding occurs more often and the effect of rounding is more pronounced after high triggers.

4.3 Contemporary Labial Harmony Outlined

In the sections above I addressed the quantitative measures used to characterize the effect of rounding on post-initial vowels, but these results, in and of themselves, do not directly speak to the contemporary status of Kazakh labial harmony in categorical terms. The following generalizations characterize the data collected, although there is very real inter-speaker variation. Vowels whose surface realization has changed since Korn's description are underlined below.

(4)

Previous description (Korn 1969)	My description	Gloss
tøbø-lør	*tøbe̱-le̱r*	'hill-PL'
ʒʏzʏm-dør	*ʒʏzʏm-de̱r*	'grape-PL'
kømʏr-dʏ	*kømʏr-dɪ̱*	'coal-ACC'
øt-tʏ-ŋ-dør	*øt-tɪ̱-ŋ-de̱r*	'pass-PST-2-PL'
kʏn-dør	*kʏn-de̱r*	'day-PL'
kʏl-dʏ	*kʏl-dɪ̱*	'laugh-PST.3'
qʊɫʊp-tʊ	*qʊɫʊp-tə̱*	'lock-ACC'
qozʊ-nʊ	*qozə̱-nə̱*	'lamb-ACC'
qʊs-ta *qʊs-to	*qʊs-ta*	'bird-LOC'
qʊs-tʊ	*qʊs-tə̱*	'bird-ACC'
qozʊ-ɫar-də *qozʊ-ɫor-dʊ	*qozə̱-ɫar-də*	'lamb-PL-ACC'

Generally, round vowels may surface in two contexts: in initial syllables, and among root-internal high vowels if the initial vowel is round. Among back vowels there is an additional

restriction- within roots, high vowels are rounded if the trigger vowel is also high. It is possible to construe rounding as a static co-occurrence restriction, and no longer a dynamic process in the language. However, viewing thie decay of rounding harmony along these lines does not explain why the rounding of root-internal vowels depends on vowel height. If all root vowels were lexically specified for roundness, then one would expect to find rounding of second syllable vowels in words like *tøbe* 'hill' *(*tøbø)* or *qozə* 'lamb' *(*qozʊ)*. Explaining the difference between high and non-high root-internal vowels is parallel to the well-known asymmetry in Turkish, where suffix vowel targets agree in roundness with the most proximate trigger if the target is high (e.g. Clements & Sezer 1982). Moreover, the distribution of round vowels within roots further parallels the distribution of round vowels in other related languages, like Kyzyl and Kachin Khakas (Korn 1969:102-103), as well as Chulym Tatar (Anderson & Harrison 2004). Kyzyl Khakas, for instance, prefers front and high vowel triggers, like Kazakh. With this in mind, the distribution of root-internal vowels in Kazakh, as in Tuvan (Harrison & Kaun 2000) is treated herein as the product of dynamic rounding harmony rather than a static co-occurrence restriction among roots.

Another reason to conclude that rounding harmony is still an active process in the language is the group of exceptions to the generalizations above. Apart from occasional exceptions that seem random, high, and occasionally non-high, post-initial vowels may be round if only one consonant intervenes between trigger and target. The frequency of this co-articulatory rounding is inversely proportioned to the duration of the intervening consonant, where the most likely consonants to allow the spreading of the lip rounding gesture are the shortest. In Kazakh, liquids are articulated with very brief obstruction of the oral cavity in Kazakh The rhotic is realized as a flap intervocalically, and the liquid is realized very similarly. The following forms are attested:

(5)

øl-ɣ̠p ∼ øl-ɪp	'die-CVB'
kɣl-ɣ̠p-tɪ ∼ kɣl-ɪp-tɪ	'laugh-PTCP-PST.3'
kɣl-ø̠-dɪ ∼ kɣl-e̠-dɪ	'laugh-NPST-3'
qʊr-ʊ̠p ∼ qʊr-ə̠p	'construct-CVB'
qʊs-ə̠p *qʊs-ʊ̠p	'vomit-CVB'
qʊr-ʊ̠ɬ-ʊ̠p ∼ qʊr-ʊ̠ɬ-ə̠p ∼ qʊr-ə̠ɬ-ə̠p	'construct-PASS-CVB'

I believe this rounding is a coarticulatory effect distinct from root-internal harmonic activity. Root-internally, intervening segments have no blocking effect on rounding. In fact, within a rounding harmonic domain, all segments are produced with rounded lips (Dzhunisbekov 1972; Abuov 1994; Vajda 1994). Spectral data from fricatives illustrates this effect, as high frequency noise is lowered in rounded segments (Fant 1971:64), as in [s] in *qʊs-tə* 'vomit-PST.3' below.

When the aperiodic noise of [s] in *qʊs-tə* and *qəs-tə* are compared (see Figures 13 and
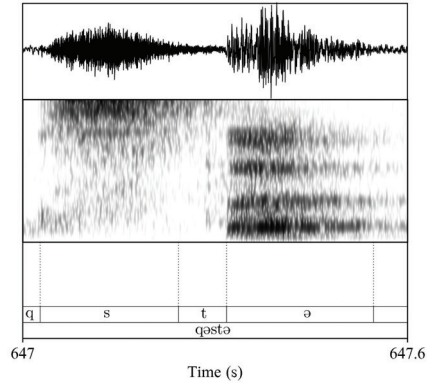
Figure 13: Waveform and spectrogram of Speaker 1 producing *qəs-tə* 'press-PST.3'
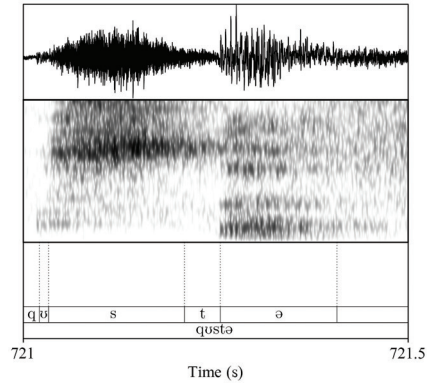
Figure 14: Waveform and spectrogram of Speaker 1 producing *qʊs-tə* 'vomit-PST.3'

14), a lower spectral peak is evident in the fricative after [ʊ]. When these spectral peaks at the midpoint of each fricative were analyzed using PRAAT's LPC function, a peak was found at 3453 Hz in *qʊs-tə*, and the corresponding peak in *qəs-tə* was at 5237 Hz. This same acoustic effect of rounding on fricatives is attested in Turkish (Ní Chiosáin & Padgett 2001).

In contrast to the labializing effect of round roots on root-internal fricatives, fricatives appear to block rounding of suffix vowels. As in (5), rounding of the high back suffix vowel in *qʊs-əp* 'vomit-CVB' (*qʊs-ʊp*) is unattested, but sometimes surfaces with words like *øl-ɣp* 'die-CVB' and *qʊr-ʊp* 'construct-CVB'. The difference between contexts where this coarticulatory rounding occurs is temporal. Consonants of longer duration, like fricatives, prevent rounding from affecting subsequent vowels. The liquids are produced with very short obstructions whereas the duration of the fricative is much longer. Between these two extremes stops and nasals both to varying degrees allow rounding of suffix vowels. In addition to the relative frequency of rounding of suffixes after liquids, rounding of non-high front vowels after a liquid is also sporadically attested, as in *kɣl-ø̈-dɪ*. Post-initial rounding of non-high vowels was almost never attested elsewhere in the data.[9] Rounding of the non-back vowel is unattested, even after liquids.

One more context-driven instance of rounding deserves mention. The only underlyingly specified suffix morpheme for [+round] is the deverbal gerundial suffix, GER. This suffix varies according to palatal context, surfacing as [ɣw] after front vowel stems, and as [uw] after back vowel stems. When a second syllable vowel occurs between a round root and GER it is almost always rounded, as in [qos-ʊɬ-uw] 'add-PASS-GET'. Even rounding after [o] generally obtains in this particular context. When additional consonants intervene, as in [qos-tər-uw] ∼ [qos-tʊr-uw] 'add-CAUS-GER', rounding is more variable. With other vowels this effect of intervening consonants is not noticeable, another indication of variable trigger strength. The gerundial suffix even triggers rounding of vowels after unrounded vowel roots when a high vowel immediately follows GER and is itself followed by a labial consonant, as in [kel-ɣw-ɣ-m] 'come-GER-POSS-1S', but not in [kel-ɣw-ɪ-ŋ] 'come-GER-POSS-2S'.

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[9]These types of subphonemic effects have been noted in a variety of other languages, too, e.g. Laal (Lionnet 2013) and Kaska (Hansson & Moore 2014).

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(6) *qos-tə̆r-uw* ∼ *qos-tʊ̆r-uw*   'add-CAUS-GER'

   kʏl-dʏ̆r-ʏw   'laugh-CAUS-GER'

   øl-dʏ̆r-ʏw   'die-CAUS-GER'

   qʊr-ʊ̆ɫ-uw   'construct-PASS-GER'

   qos-ʊ̆ɫ-uw   'add-PASS-GER'

   qas-uw-ʊ̆-m   'scratch-GER-POSS-1S'

   qas-uw-ə̆   'scratch-GER-POSS.3'
   qas-uw-ʊ̆

   kel-ʏw-ʏ̆-m   'come-GER-POSS-1S'

   kel-ʏw-ɪ̆-ŋ   'come-GER-POSS-2S'
   kel-ʏw-ʏ̆-ŋ

These instances demonstrate the combined coarticulatory effects of GER with round roots, as well as GER with adjacent [m]. No other labial consonants may occur in the appropriate context to trigger this type of rounding, but I assume that this effect would likely occur if the appropriate morphological environment were possible.

5   Analysis

5.1   Pathways of Decay

Throughout Section 4, I showed that labial harmony is greatly diminished in contemporary Kazakh. This reduction in rounding post-initially has occurred along two lines: domain contraction, where the active domain for rounding has been reduced from the word to the root, and the concomitant neutralization to [-round] outside the root and among non-high vowels. In this section I address these two interwoven aspects of this recent change.

5.1.1   Domain Contraction

As observed in Section 4.2.1, labial harmony "peters out" in contemporary Kazakh. Vowels that are closer to the word-initial vowel are more likely to be affected by rounding. Additionally, morphology interacts with harmony, with root-internal vowels more often being rounded than suffix vowels. Among suffixes, the occasional instances of rounding follow this same pattern, where first suffix vowels are more likely to be rounded than second suffix vowels. McPherson and Hayes use proximity as defined in Lexical Phonology (Kiparsky 1982), where an affix is more proximate to the root if its order with respect to another affix is fixed.

Thus, the plural morpheme in Kazakh is more proximate than case morphemes because the plural morpheme must precede case marking in the rightward construction of complex words in the language. The details of this approach are not explored herein, but offer a potentially-insightful approach to further analyzing the data. Rather than arguing for the relative proximity of any particular morpheme or stratum of morphemes, I only note that the harmonic domain is defined in morphological rather than phonological terms. In contrast to the Central dialect of Crimean Tatar (Kavitskaya 2010, 2013) and Karakalpak (Menges 1947), where the labial harmonic domain is two syllables, Kazakh defines the domain of harmony in a more restrictive way. In the Central dialect of Crimean Tatar and Karakalpak, rounding obtains for all eligible targets[10] within the two-syllable domain regardless of morphological constituency, as in (7) below. Kazakh only permits categorical rounding within a morpheme, so rounding across morphemic boundaries is generally prohibited.

(7)	Kazakh	Karakalpak	Crimean Tatar	Gloss
	mʊɾʊn	*murun*	*burun*	'nose'
	ʒuw-ən-də	*ʤuv-un-də*	*juv-un-dɯ*	'wash-REFL-PST-3'

The contracted domain in contemporary Kazakh is, in effect, an another restriction on top of the two-syllable domain present in Karakalpak and Central Crimean Tatar. It seems likely that this additional restriction is a further landmark in the decay of labial harmony. Descriptions by Menges and Korn suggest that Kazakh used to round post-initial vowels more extensively, likely throughout the entire word. Dzhunisbekov's description, on the other hand, generally confines labial harmony to two-syllables, but no differences emerge from root-internal versus suffix vowels in his analysis. Thus, this further constraint on rounding is plausibly another indicator of the decay of this process in the language.

5.1.2 Neutralization

At the beginning of the 20th century almost all Kazakhs spoke Kazakh as their first language. By the end of the Soviet era perhaps half had reasonable command of the language (Kirchner 1998; Dave 2002). The grammatical changes evident in many speakers is typical of language attrition scenarios. It is often argued that in these scenarios the phonological changes are typically simplificational in nature (e.g. Andersen 1982), and that these changes favor the unmarked (Campbell & Muntzell 1989). Therefore, for each [±round] pair neutralization should favor the unmarked. If markedness is defined along the lines ease of articulation, perception, and by extension, cross-linguistic frequency, the following generalizations should hold. Among front vowels, [ɪ] and [e] should be favored over [ʏ] and [ø], respectively. Among back vowels, similarly, [ə] and [o] should be preferred over [ʊ] and [ɑ].[11] However, in the non-

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[10]In Crimean Tatar, only high vowels serve as targets, whereas in Karakalpak non-high vowels are also eligible targets if the root is a front vowel.

[11]I transcribe the high back unrounded vowel as [ə], as do Dzhunisbekov (1972) and Vajda (1994). Additionally, Johanson (1998:92-94) notes the lowering and centralization of the high vowels in Kazakh. However, most Turcologists transcribe this vowel as [ɯ].

high back context, the marked vowel, [ɑ] has historically surfaced instead of the less marked [o]. In the languages referenced in (6) above, it is likely than neutralization to [-round] in the high back environment also involves post-initial neutralization to the more marked segment . When comparing [u] to [ɯ] the infrequency of the [-round] vowel is clear from cross-linguistic data in Table 4 (from Moran et al. 2014; cf. de Lacy 2006:30-31).

Table 4. Kazakh harmonic vowels and their cross-linguistic frequency (Moran et al. 2014)

Vowel	Number of languages attested in (N=2155)	Frequency of attestation	Frequency compared to harmonic pair
ɑ	126	5.85	11.58/7.1x less frequent
o/ɔ	1459/894	67.7/41.48	
ə/ɯ	508/133	23.57/6.17	1.49x more/2.56x less
ʊ	341	15.82	frequent
e	1458	67.66	28.04/104.14x more
ø/ɵ	52/14	2.42/0.65	frequent
ɪ	362	16.8	30.17x more frequent
ʏ	12	0.57	

When the Kazakh data is considered, the language does exhibit a case of simplificational change, at least in some sense. The number of post-initial round vowels has been reduced from three to two, with a very limited distribution for those two vowels. However, a problem emerges when the typical view of markedness is invoked. The most marked vowels are, in fact, the vowels that continue to surface while unmarked vowels like [o] and [ʊ] are more likely to be neutralized in post-initial contexts. Walker (2013) notes this very issue for the treatment of Korn's Kazakh data. Framed in terms of constraints, the vowels that surface in the language support the following markedness hierarchy:

$$*o >> *ø >> *ʊ >> *ʏ$$

In the above hierarchy non-high rounded vowels are more marked than high rounded vowels and back vowels are more rounded than front rounded vowels. However, if cross-linguistic data is used to construct a markedness hierarchy, a conflicting hierarchy is generated

$$*ʏ >> *ø >> *ʊ >> *o$$

In the cross-linguistically informed hierarchy, front rounded vowels are more marked than back rounded vowels, and lax vowels are more marked than tense rounded vowels. The well-known generalization that back vowels tend to be round and front vowels tend to be unrounded, evident in the second hierarchy is flouted by the trajectory of this phonological change in Kazakh. The most marked vowels persist while the least marked vowels are neutralized. A segment-specific conception of markedness cannot adequately address this surprising trajectory of decay (McCollum 2015a; also Walker 2013).

5.2   Motivations for Decay

Harrison et al. (2002) attempt to model harmonogenesis as well as harmonic decay using an agents-based computational model. They successfully model a plausible S-curve reflecting the advent of harmony in Uzbek by using a variety of language-internal and social factors. However, their model fails to successfully model the decay of harmony. They view loanwords and vowel mergers as factors driving decay, and additionally note the likelihood of language contact in their model. Binnick (1991:38), however, contends that vowel harmony systems may be inherently unstable. Moreover, Dombrowski (2013) notes that other language-internal factors not included in Harrison et al.'s model, like underspecification, may contribute to the loss of harmony.

When labial harmony is viewed along perceptual lines (e.g. Kaun 1995), it is possible that underspecification accurately reflects a perceptual impoverishment of post-initial vowels. In Turkic languages, vowel height is the only intrinsically specified feature in a harmonic vowel. Backness and, to some degree, rounding are determined by the features of the root vowel. These alternating suffixes, as opposed to invariant morphemes, fall under Inkelas' criterion for being underspecified (1995; cf. Harrison & Kaun 2001). If alternating segments are actually underspecified (a notion that is inherently opposed to canonical Optimality Theory: Prince & Smolensky 1993; Smolensky 1996; Bakovic 2000), this underspecification runs counter to Lexicon Optimization. The argument is thus: a universal pressure is exerted on languages to fully specify all segments regardless of alternation. This pressure runs counter to the language-specific implementation of harmony. Following Dombrowski (2013), I suggest that this tension is a potential factor influencing the decay of harmony in Kazakh, where the underlying representations of post-initial vowels are perceptually impoverished as a result of harmony. Therefore, one byproduct of harmony, namely underspecification, potentially undermines the process from which it emerges, making vowel harmony an inherently unstable phenomenon, in accord with Binnick's earlier proposal.

6   Conclusion

Herein I have provided a contemporary description of labial harmony in Kazakh and the ways this harmonic process have changed since previous descriptions. Taking Korn (1969) as a starting point and subsequent mentions of decay (Dzhunisbekov 1972; Vajda 1994; Kirchner 1998; Kara 2002) as indications of the direction of change, I provided a bottom-up analysis of Kazakh data, modeling the effect of harmony in a mixed effects model as well as a discriminant analysis. The nature and trajectory of changes since Korn's description are then extrapolated from statistical findings to propose a description of the current working of labial harmony in the language. From this description multiple theoretical issues emerge: the morphological and phonological nature of harmonic domains, the pathways of neutralization, and underspecification as a potential motivation for decay. Addressing these questions from a variety of theoretical and experimental avenues may aid further research toward a fuller understanding of vowel harmony and harmonic decay.

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