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Acceptability of the Kazakh Velar and Uvular Distribution

Heather Lynn Yawney*

Abstract. This study investigates the productivity and distribution of place and voicing restrictions in Kazakh oral dorsals. Previous research discusses a place restriction in native words, whereby velars occur with front vowels and uvulars with back vowels; a voicing restriction across all words, whereby stem-final dorsal obstruents are voiceless word-finally and voiced intervocalically; and the occurrence of the voiceless dorsal fricative only in loanwords, where it is not subject to the place restriction, but it remains unclear whether the voicing restriction applies. Two nonce word judgement tasks were conducted with native Kazakh speakers. The first task focused on word-final dorsals. Participants generally accepted licit forms and rejected illicit forms, with gradience in acceptability suggesting a preference for voicing over place. Within the voicing categories, forms obeying place were judged more favourably. The second task examined stem-final alternations in an inflected paradigm, and revealed that participants preferred paradigms satisfying place in both bare and inflected forms, with stronger preference for place being respected in inflected forms. Regarding the voiceless dorsal fricative, the results suggest that it patterns more closely with uvulars, but it was generally rejected, likely due to its restriction to loanwords and lack of integration into native phonology.

Keywords. Kazakh; dorsals; velars; uvulars; place of articulation; voicing; gradient acceptability; acceptability judgements.

1. Introduction. Most Turkic languages have velar and uvular (dorsal) consonant inventories.[1] While the specific dorsals vary within this language family, many Turkic languages exhibit place of articulation and voicing restrictions. However, detailed descriptive and experimental work on these restrictions in Turkic languages remains limited. This study aims to help bridge the gap by investigating how these restrictions operate on Kazakh velars and uvulars, and whether they are productively extended to nonce forms.

This paper is organised as follows. Section 2 presents background information about what is known about Kazakh velars and uvulars. Section 3 presents the guiding research questions and a short description of two acceptability judgement tasks. Section 4 discusses the design and results of the word judgement task. Section 5 discusses the design and results of the paradigm judgement task. Section 6 concludes with an overall discussion of the results of the two tasks. Section 7 briefly concludes.

2. Background. Kazakh dorsals have already been discussed in the literature. Several properties are already known about Kazakh velars and uvulars. First, the number of velar and uvular consonants is asymmetrical (Section 2.1). Second, the place restriction exhibits velar and uvular alternants depending on neighbouring vowels (Section 2.2). Velars appear in front vowel envi-

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Heather Lynn Yawney, University of Toronto (heather.yawney@mail.toronto.ca).

[1] See Johanson and Johanson (1998). This book offers overviews of different Turkic languages written by different authors.

ronments and uvulars appear in back vowel environments in native Kazakh words (Muhamedowa 2016). Third, the voicing restriction depends on the position of the stem-final velars and uvulars within a word (Section 2.3). Word-final velars and uvulars are voiceless and stem-final intervocalic velars and uvulars are voiced with a following vowel-initial suffix in all Kazakh words (Kara 2002). Fourth, loanwords, including words containing the voiceless dorsal fricative (henceforth represented broadly as /X/) are exceptions to vowel harmony and can remain non-harmonic (Bekturova & Bekturov 1996) (Section 2.4). Nothing is known about what happens to /X/ found in loanwords, and it is unclear whether /X/ exhibits any place of articulation or voicing restrictions.

2.1. VELAR AND UVULAR CONSONANT INVENTORY. Kazakh includes an inventory of five oral dorsal consonants. The inventory, shown in (1), contains a mixture of native and foreign sounds.

(1) Kazakh velar and uvular consonants[2]

	VELAR		UVULAR	
STOPS	k <ĸ/k>	ɡ <ғ/g>	q <қ/q>	
FRICATIVES	x <х/h>		χ <х/h>	ʁ <ғ/ğ>

Each consonant is represented by a distinct grapheme in the Kazakh writing system. Both the Cyrillic-based (right) and Latin-based (left) symbols are given in (1). The inventory exhibits asymmetries. For instance, the voiceless uvular stop does not have the voiced uvular stop [ɢ] counterpart, or the counterpart to the voiced velar stop [ɡ] is the voiced uvular fricative [ʁ]. Additionally, both the voiceless velar and uvular fricatives appear in greyed-out cells in (1) to indicate a single voiceless fricative in Kazakh. This reflects my uncertainty from the literature as to whether this fricative is velar [x] or uvular [χ].

2.2. PLACE RESTRICTION. Velars and uvulars are restricted in their place of articulation depending on the surrounding vowel environment (Muhamedowa 2016). Similar to many other Turkic languages, vowel harmony is a key feature found in native Kazakh words, whereby all vowels in a word are either front or back. This affects whether a velar or uvular appears within a words. Due to vowel harmony, each word contains only front or back vowels, as the examples show in (2).

(2) Examples of front and back vowel harmony within a word (after Bekturova & Bekturov 1996; Bowman & Lokshin 2014)

FRONT VOWELS WITH VELAR CONSONANTS		BACK VOWELS WITH UVULAR CONSONANTS	
[ʃemɪrʃe**k**]	‘gristle’	[ʒomɯrt**q**ɑ]	‘egg’
[**k**yre**k**]	‘shovel’	[sɑrɯmsɑ**q**]	‘garlic’
[esɪ**k**]	‘door’	[**q**ɑlɑm]	‘pen’
[**k**epemet]	‘amazing’	[**q**ɑʁɑz]	‘paper’
[tyn**g**ɪ]	‘night time’	[bɑʁɑn]	‘column’
[sø**g**ɪs]	‘pasture’	[**ʁ**ɑlɯm]	‘scholar’
[ʃɪ**g**ɪt]	‘young’	[bɑlʁɑ]	‘hammer’

[2]Voiceless sounds are on the left side and voiced sounds are on the right side of the place columns.

These examples show that velars appear with front vowels and uvulars appear with back vowels. The distribution adheres to Kazakh phonotactics governing where each dorsal consonant may occur in native words.

Vowel harmony and the distribution of velars and uvulars also extend into the morphological system. Many suffixes in Kazakh exhibit both front and back alternants, harmonising with the stem and a suffix-initial obstruent assimilating in voicing to the preceding stem-final consonant (see Muhamedowa 2016). This is evident in the alternation patterns of the dative suffix /-GA/, shown in (3).[3]

(3) Harmony with the dative suffix /-GA/

FRONT VOWELS

	STEM		STEM-DAT	
a.	[keme]	'ship'	[keme-**ge**]	'to the ship'
b.	[ʃelek]	'bucket'	[ʃelek-**ke**]	'to the bucket'
c.	[sæbɪz]	'carrot'	[sæbɪz-**ge**]	'to the carrot'

BACK VOWELS

	STEM		STEM-DAT	
d.	[ɑwɑ]	'air'	[ɑwɑ-**ʁɑ**]	'to the air'
e.	[bɑs]	'head'	[bɑs-**qɑ**]	'to the head'
f.	[tuz]	'salt'	[tuz-**ʁɑ**]	'to the salt'

These examples show that the realisation of the dative suffix /-GA/ depends on the voicing of the stem-final consonant and on whether the stem contains front or back vowels. In front vowel environments (3a–c), /G/ surfaces as velar [k] or [g], and /A/ as [e]. In back vowel environments (3d–f), /G/ surfaces as uvular [q] or [ʁ], and /A/ as [ɑ]. Furthermore, /G/ is realised as voiceless [k] or [q] when following voiceless consonants (3b, e), and as voiced [g] or [ʁ] elsewhere (3a, c, d, f).

2.3. VOICING RESTRICTION. Velars and uvulars are also restricted in voicing depending on the position of the stem-final consonant in a word (Kara 2002). As in many other Turkic languages, the voicing alternation at the morpheme boundary is a key feature found in all Kazakh words, whereby stem-final velars and uvulars must be voiceless word-finally (left column in (4)) and voiced intervocalically (right column in (4)).

(4) Examples of velar and uvular alternations (after Bekturova & Bekturov 1996)

	WORD-FINAL		INTERVOCALIC	
VELAR	[kywælɪ**k**]	'identity card'	[kywælɪ**g**ɪm]	'my identity card'
UVULAR	[qɑsɯ**q**]	'spoon'	[qɑsɯ**ʁ**ɯ]	'his/her spoon'

These examples show that voiceless velars and uvulars appear word-finally, and voiced velars and uvulars appear intervocalically with a following vowel-initial suffix (Kara 2002). The stem-final voiced and voiceless pairs of velars and uvulars alternate depending on the position within the word, though it is unclear whether this reflects word-final devoicing or intervocalic voicing. This behaviour contrasts with stem-internal velars and uvulars, which can be voiced or voiceless in the syllable onset position, as in [ekɪ] 'two', [segɪz] 'eight', [bɑqɑ] 'frog', and [bɑʁɑ] 'price', and in the coda position, as in [mektep] 'school', [egde] 'elderly', [tɑqtɑ] 'chalkboard', and

[3]Capital letters are used to represent underlying representations that are unspecified due to consonant assimilation or vowel harmony. In /-GA/, /G/ represents a dorsal obstruent unspecified for velar/ uvular place of articulation and voicing, , while /A/ represents an unrounded non-high vowel unspecified for backness.

[ʒɑʁdɑj] ‘situation’ (McCollum & Chen 2021: 278–279). Also, nothing is known about whether the articulation of stem-final [X] alternates in voicing depending on its position in a word.

2.4. LOANWORDS. Loanwords are exceptions to vowel harmony and can remain nonharmonic, like the examples shown in (5) (Kara 2002; Muhamedowa 2016).

(5) Loanwords in Kazakh (after Batayeva 2013; Kara 2002)

a.	[kɪtɑp]	‘book’	(Arabic)
b.	[piʁɯl]	‘aspiration, intention’	(Arabic)
c.	[gæwhɑr]	‘pearl’	(Persian)
d.	[qɑreket]	‘sort of blouse’	(Persian)
e.	[ɑkɑdemik]	‘academic, academician’	(Russian)
f.	[begemot]	‘hippopotamus	(Russian)
g.	[tɑriX]	‘history’	(Arabic)

Words containing /X/ also show the same disharmony, as shown in (6).

(6) Loanwords in Kazakh (after Batayeva 2013; Kara 2002)

a.	[Xɑlɯq]	‘people’
b.	[Xɑlifɑt]	‘caliphate’
c.	[buXgɑlter]	‘accountant’
d.	[nɑsiXɑt]	‘propaganda’
e.	[tɑrijX]	‘history’
f.	[puX]	‘spirit’

These examples in (5) and (6) show that loanwords do not follow the native Kazakh vowel harmony pattern and can contain both front and back vowels within the same word. The dorsal consonants can occur next to either front or back vowels. The fricative [X] is reported to alternate freely with the voiceless uvular stop [q], as in [Xɑt]~[qɑt] ‘letter’ (Bekturova & Bekturov 1996; Muhamedowa 2016). However, there is no clear evidence in the literature regarding whether the articulation of [X] varies systematically depending on the vowel environment.

3. Research questions and experiments. The background discussion reviewed what is already known about Kazakh velars and uvulars. However, the existing descriptions of Kazakh contain limited amounts of data and explanation. In native Kazakh words, dorsal consonants are constrained in their place of articulation based on adjacent vowels; velars appear in front vowel environments, while uvulars appear in back vowel environments. This demonstrates a clear influence of vowel quality on neighbouring consonants. Additionally, in all Kazakh words, the voicing of stem-final dorsal consonants is positionally restricted; voiceless dorsals appear word-finally, whereas voiced dorsals occur intervocalically when followed by a vowel-initial suffix. This pattern illustrates how laryngeal features can change at morphological boundaries. Finally, /X/ stands out as an exception. Unlike other dorsals, it can occur in both front and back vowel environments. However, this segment only appears in loanwords, and reflects lest restrictive phonotactic constraints applied to borrowed vocabulary, as opposed to native words that are subject to vowel harmony.

Despite these general descriptions, the information available on Kazakh velars and uvulars is drawn from several different sources that offer minimal amounts of detail, leaving the representation of velars and uvulars for native Kazakh speakers unclear. The existing accounts provide limited data and explanation, making it difficult to draw broad conclusions about the full distribution and behaviour of dorsal consonants in Kazakh. This leaves several important questions

open: Is the place of articulation restriction actively enforced? Is the voicing alternation productive? Do velars and uvulars contrast in intervocalic environments? What is the status and behaviour of /X/?

A growing body of work has shown that patterns observed in the lexicon may be extended productively to nonce words. The use of nonce words in experiments was pioneered by Berko (1958) and has been used extensively in phonological research since. Ernestus and Baayen (2003) demonstrate that Dutch speakers reflect the underlying characteristics of the Dutch lexicon regarding the voicing neutralisation of final obstruents in their production of nonce words. The velars were interpreted as underlyingly voiced relatively more than coronals and labials. Becker et al. (2011) illustrate that Turkish speakers match the generalisations about the distribution of the voicing alternation at the right edge of nominal stems relative to their size and the place of articulation of the final stop. More voicing alternations were preferred in longer words and with final labials. Jurgec and Schertz (2020) show that Slovenian speakers have a productive general co-occurrence restriction against multiple non-adjacent postalveolars within a word, in both derived and non-derived environments. Multiple postalveolars were dispreferred within a word and, more specifically, the degree of unacceptability was modulated by the proximity and the identity of the two postalveolars.

To explore these above questions, I conducted two online nonce word acceptability judgement tasks using Gorilla Experiment Builder (Anwyl-Irvine et al. 2018) to investigate whether native Kazakh speakers extend the place of articulation and voicing restrictions to nonce words, as well as to discover how /X/, found only in loanwords, is treated. Participants accessed the tasks via a web link and completed the task remotely on their own devices. Both tasks involved nonce words with licit and illicit stem-final vowel-consonant sequences. The first task focused on word-final dorsals with 90 participants who judged the acceptability of 20 licit or illicit CVCVC-shaped bare nonce words varying in (i) the stem-final dorsal and (ii) vowel backness. The second task focused on stem-final dorsals with 78 participants judging 32 nonce word pairs in a paradigm, where the first member was a bare CVCVC-shaped root and the second member was the root inflected with the first-person singular possessive suffix /-Im/[4]. The nonce word pairs varied in (i) the stem-final dorsal, (ii) vowel backness, and (iii) place of articulation alternation of the stem-final dorsal across the paradigm. The acceptability judgements provide insight into how native Kazakh speakers distinguish (un)grammaticality of nonce words, based on the different combinations of illicit stem-final vowel-consonant sequences, and reveals how acceptability does or does not align with the production.

4. Word judgement task. I first ask whether native Kazakh speakers productively apply the place of articulation and voicing restrictions on word-final dorsals when judging nonce words. That is, are nonce words more acceptable when they conform to the phonological restrictions, and less so when they do not? To test this, the word judgement task involved asking native Kazakh speakers to judge the acceptability of CVCVC-shaped bare none words. CVCVC shape is licit in Kazakh, but the stimuli varied in their stem-final vowel-consonant sequence—specifically whether they conformed to or violated Kazakh's dorsal place of articulation and voicing restrictions.

The results largely confirm that participants preferred nonce words that respected both the place of articulation and voicing restrictions. Words ending in /k/ in front vowel environments and words ending in /q/ in back vowel environments had the highest acceptability rates. When

[4] /I/ in this suffix has the allophones [ɪ] and [ɯ] to harmonise with the backness of the stem vowels.

violations occurred, participants favoured respecting the voicing restriction over respecting the place of articulation restriction. This means that word-final /q/ in front vowel environments and /k/ in back vowel environments had higher acceptability than word-final /g/ in front vowel environments and word-final /ʁ/ in back vowel environments. Words that violated both the place of articulation and voicing restrictions had the lowest acceptability rates. These results can be summarised in Table 1.

Property	Result
Strongest preference: Voicing	voiceless > voiced
Next preference: Place of articulation	velar > uvular (with front vowels) uvular > velar (with back vowels)
Weakest preference: /X/	with back vowels > with front vowels

Table 1. Summary of properties and the preferred result for the word judgement task

In the following subsections, I will discuss the word judgement task design (Section 4.1) and discuss the results (Section 4.2) in more detail.

4.1. EXPERIMENTAL DESIGN. 90 native Kazakh speakers participated in the word judgement task designed to test the acceptability of phonotactically licit and illicit bare nonce words. Each participant evaluated 20 nonce words of the shape $C_1V_1C_2V_2C_3$. The bare nonce word stimuli varied according to (i) the stem-final dorsal consonant (C_3) and (ii) the vowel backness of the two vowels (V_1 and V_2). The target stem-final dorsals included the five dorsals, [k], [g], [q], [ʁ], and [X], while the target vowels were front vowels, [ɪ] and [e], and back vowels, [ɯ] and [ɑ]. The two vowels in each bare nonce word shared the same backness but differed in height. The remaining filler consonants (C_1 and C_2) were selected from [b], [m], [s], and [t], chosen to represent different combinations of place of articulation, manner of articulation, and voicing distinctions.

For each combination of stem-final dorsal consonant and vowel backness, five different nonce words were generated, such as *bɪs**ek***, *mɪt**ek***, *sɪb**ek***, *sɪm**ek***, and *tɪm**ek*** for the final *ek* combination. In total, 100 nonce words were generated. The bare nonce word stimuli were created by splicing together segments from recordings of phonotactically licit nonce words produced by a native Kazakh speaker. The source recordings followed Kazakh phonotactic constraints, with nonce word shapes $C_1V_1C_2V_2C_3$ and $C_2V_2C_3$Im, with all consonants and vowels adhering to Kazakh's restrictions on place of articulation and voicing. Stimuli containing /X/ included splices from nonce words with the same vowel backness as the target stimulus.

Participants heard one randomly selected nonce word from each of the 20 groups, defined by the stem-final dorsal and adjacent preceding vowel, and the order in which they heard the stimuli was randomised for each participant. After playing each audio stimulus, participants were asked to decide whether the word could be a possible new Kazakh word. They indicated their judgment by selecting one of two options: "okay" if the word was judged acceptable, or "not okay" if it was not.

4.2. RESULTS. If Kazakh speakers productively apply the place of articulation and voicing restriction, we expect them to judge grammatical patterns as more acceptable than ungrammatical ones. Specifically, voiceless dorsals should be preferred word-finally, with velars preferred over uvulars in front vowel environments, and uvulars over velars in back vowel environments. However, it is unclear how the place of articulation and the voicing restrictions interact with each other—

e.g. whether /q/ or /g/ is preferred in front vowel environments or /k/ or /ʁ/ in back vowel environments—is unclear, so I will let the results speak for themselves. For /X/, I expect generally high acceptability in both vowel environments.

Across the 90 participants, a total of 1771 out of 1800 expected acceptability judgements were registered (98%). The remaining 29 (2%) judgements were likely missed due to participants not selecting one of the 'okay' or 'not okay' options correctly. Average judgements across participants were calculated for each stem-final dorsal by vowel backness are given in Figure 1 with each acceptability judgement coded as 0 if a participant judged the nonce word as unacceptable and as 1 if they judged it as acceptable.

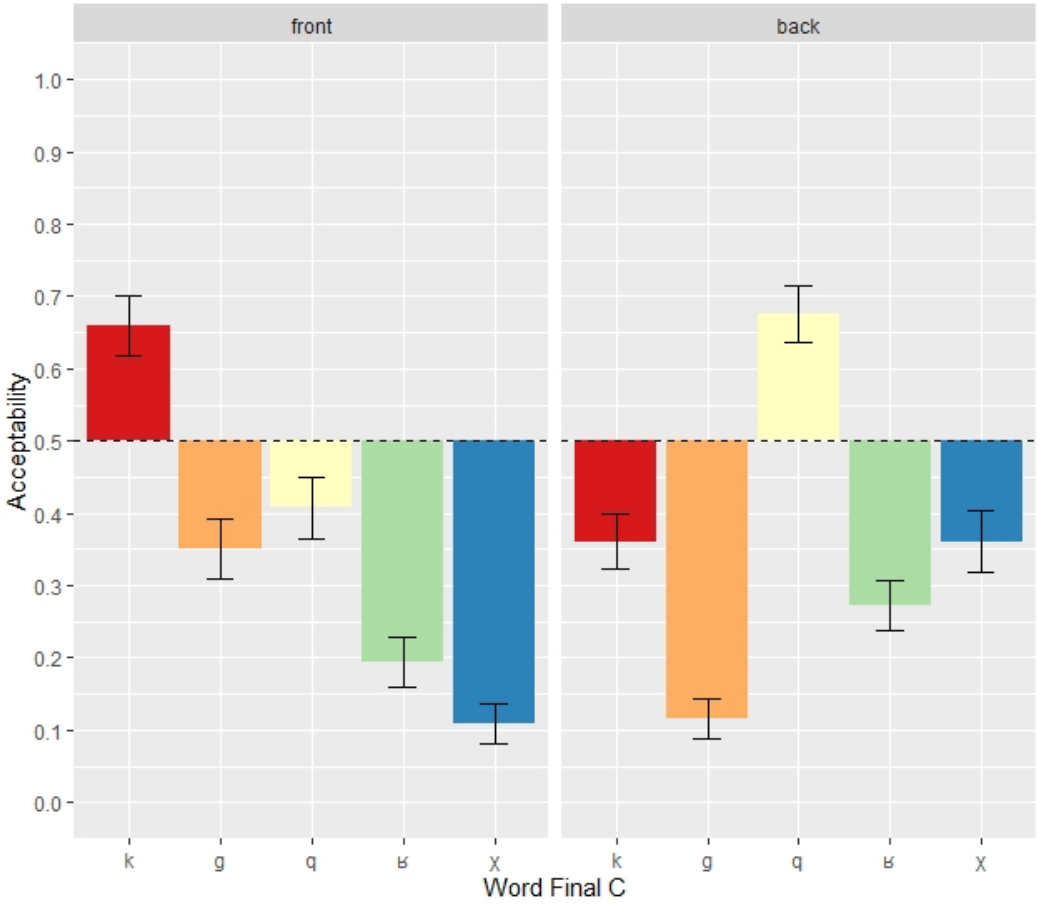

Figure 1. Mean acceptability values for word-final dorsals in front and back vowel environments

These results largely confirm a preference for grammatical bare nonce words: word-final /k/ in front vowel environments (mean 66%) and word-final /q/ in back vowel environments (68%) had the highest acceptability. Ungrammatical nonce words respecting the voicing restriction were favoured over those respecting the place of articulation restriction. Word-final /q/ in front vowel environments (42%) and word-final /k/ in back vowel environments (37%) had higher acceptability than word-final /g/ in front vowel environments (36%) and word-final /ʁ/ in back vowel environments (27%). Nonce words violating both restrictions had the lowest acceptability, that is, word-final /ʁ/ in front vowel environments (19%) and word-final /g/ in back vowel environments (11%). Finally, nonce words with word-final /X/ had low acceptability overall, though it

had higher acceptability in back vowel environments (37%) than in front vowel environments (11%).

The acceptability judgements were analysed using a mixed effect logistic regression model (Baayen et al. 2008), using the lmer function from the lme4 package in R (R Core Team 2023) with two predictors: Vowel (backness) and (stem-final) Consonant, and included Participant as a random effect. Vowel had two levels (front and back), and Consonant had five levels (*k*, *g*, *q*, ʁ, and *X*). The model was run twice, once with front and *k* as the reference level and once with back and *q* as the reference level. Changes in vowel backness or the stem-final consonant resulted in significant decreases in acceptability, with all p-values below 0.05. These results aligned with the mean acceptability values for different vowel backness and stem-final dorsal combinations. Interactions between vowel backness and word-final dorsals were also significant, showing better than expected performances for most changes. The exceptions were *g* with back vowels (with front and *k* as the reference level) and *X* with front vowels (with back and *q* as the reference level), both of which were not significant ($p>0.05$).

5. Paradigm judgement task. I next ask whether Kazakh speakers productively the stem-final consonant alternations on stem-final dorsals within an inflectional paradigm. That is, when judging pairs of nonce words in a morphological paradigm—one bare form and one inflected form—do participants prefer alternations that conform to Kazakh's place of articulation and voicing restrictions? And when violations occur, do they favour consistency across the paradigm or adherence to phonotactic constraints? To test this, the paradigm judgment task asked native Kazakh speakers to judge the acceptability of nonce word pairs that varied in the relationship between the bare and inflected forms. Each pair included a CVCVC-shaped bare form and an inflected form with the first person singular suffix. As in the word judgment task, stimuli varied in vowel backness and stem-final consonants. Frame sentences were provided to give syntactic context.

The results largely confirm that participants preferred paradigms that respected both the place of articulation restriction and consistency between the bare and inflected forms. Participants preferred nonce word pairs in which word-final [k] alternates with stem-final intervocalic [ɡ] in front vowel environments and word-final [q] alternates with stem-final intervocalic [ʁ] in back vowel environments. When violations occurred, participants showed a clear preference for inflected forms that satisfied the place restriction (e.g. a uvular in a back vowel environment), even if this introduced a mismatch with the bare form (e.g. a velar in bare form but a uvular in the inflect form in a back vowel environment). If the inflected form violated the place of articulation restriction, participants preferred consistency in stem-final consonant across the paradigm, even if both forms violated the place of articulation restriction. The weakest preference was for mismatches where only the bare form satisfied the restriction. These results are summarised in Table 2. In each alternation, the first consonant corresponds to the word-final consonant in bare nonce forms and the second consonant corresponds to the stem-final intervocalic consonant in nonce inflected forms.

Property	Result
Strongest preference: Paradigm consistency in stem-final place and place restriction satisfied in both forms	k~ɡ (with front vowels) q~ʁ (with back vowels)
Next preference: Place restriction only satisfied in inflected form (inconsistent paradigm)	q~ɡ (with front vowels) k~ʁ (with back vowels)
Weaker preference: Paradigm consistency in stem-final place, but place restriction not satisfied in either form	q~ʁ (with front vowels) k~ɡ (with back vowels)
Weakest preference: Place restriction satisfied only in bare form (inconsistent paradigm)	k~ʁ (with front vowels) q~ɡ (with back vowels)

Table 2. Summary of properties and the preferred result for native Kazakh dorsals in the paradigm judgement task

The results for /X/ show that participants preferred nonce word pairs in which word-final [X] alternates with stem-final intervocalic [ʁ], regardless of vowel backness, indicating a preference for voicing while maintaining manner of articulation. Word-final [X] alternating with stem-final intervocalic [ɡ] was also preferred, but only in front vowel environments, and was dispreferred in back vowel environments. Word-final [X] alternating with stem-final intervocalic [X] was generally dispreferred across participants. These findings suggest that participants preferred intervocalic voicing for /X/ while maintaining manner of articulation, and that /X/ may be perceived as more uvular than velar. These results are summarised in Table 3. In each alternation, the first consonant corresponds to the word-final consonant in bare nonce forms and the second consonant corresponds to the stem-final intervocalic consonant in inflected nonce forms.

Property	Result
Strongest preference: Change in voicing Place unknown Manner maintained	X~ʁ (with front and back vowels)
Next preference: No change in voicing Place unknown Manner not maintained	X~ɡ (with front vowels, not with back vowels)
Weakest preference: No change in voicing Place unknown Manner maintained	X~X (with front and back vowels)

Table 3. Summary of properties and the preferred result for /X/ in the paradigm judgement task

In the following subsections, I will discuss the paradigm judgement task design (Section 5.1) and discuss the results (Section 5.2) in more detail.

5.1. EXPERIMENTAL DESIGN. 78 native Kazakh speakers participated in the paradigm judgement task, which tested the acceptability of phonotactically licit and illicit nonce word pairs. Each participant evaluated 32 nonce word pairs, where the first member was a bare $C_1V_1C_2V_2C_3$-shaped root and the second member was an inflected form with the first-person singular possessive suffix /-Im/ (with /I/ realised as [ɪ] in front vowel environments and [ɯ] in back vowel environments). The nonce word pair stimuli varied according (i) the stem-final dorsal consonant in the bare form (C_3#), (ii) the vowel backness of the two vowels (V_1 and V_2), and (iii) the place of articulation alternation of the stem-final dorsal across the paradigm (C_3#~C_3-Im). The target stem-final dorsals of the bare nonce member included the three voiceless dorsals, [k], [q], and [X]. The target vowels were front vowels, [ɪ] and [e], and back vowels, [ɯ] and [ɑ]; as with the word judgement task, both vowels in each nonce stem shared the same backness but differed in height. The target alternations included some grammatical ([k]~[ɡ] and [q]~[ʁ]), some ungrammatical ([k]~[ʁ] and [q]~[ɡ]), and some unknown ([X]~[X], [X]~[ɡ], and [X]~[ʁ]). The remaining filler consonants (C_1 and C_2) were selected from [b], [m], [s], and [t], chosen to represent different combinations of place of articulation, manner of articulation, and voicing distinctions

For each combination of stem-final dorsal consonant, vowel backness, and the alternation, five nonce word stems were generated, such as *bemık*, *mesık*, *semık*, *setık*, *tebık* for the final *ık* combination. In total, 60 bare nonce word roots were generated. The nonce word pair stimuli with the alternations that were grammatical, ungrammatical, or unknown were created by splicing segments from the same phonotactically licit $C_1V_1C_2V_2C_3$ and $C_2V_2C_3$Im-shaped nonce word recordings used for the word judgement task and produced by a native Kazakh consultant. The consonants and vowels from the source recordings adhered to Kazakh phonotactic constraints regarding the place of articulation and voicing restrictions. Stimuli containing /X/ included splices from nonce words with the same vowel backness as the target stimulus.

Participants heard one randomly selected nonce word pair from each of the 32 groups, defined by the stem-final dorsal in the bare nonce member and the adjacent preceding vowel. The order in which the stimuli were heard was randomised for each participant. Within each pair, the bare form was always presented first, followed by its inflected counterpart. The procedure was similar to that of the procedure for the word judgement task. After playing each audio stimulus, participants were asked to decide whether the nonce pair could be a possible new Kazakh pair of words. They indicated their judgment by selecting one of two options: “okay” if the pair was judged acceptable, or “not okay” if it was not. The key differences in the paradigm judgement task are participants were asked to judge two-word paradigms instead of individual forms and participants were given two frame sentences to give context for each member of the paradigm.

5.2. RESULTS. If Kazakh speakers productively apply place of articulation restriction in inflectional paradigms, we expect them to judge grammatical alternation patterns as more acceptable than ungrammatical ones. Specifically, [k] alternating with [ɡ] in front vowel environments and [q] alternating with [ʁ] in back vowel environments should be preferred. As for /X/, the predictions are less clear, so I remain neutral and allow the results to speak for themselves.

Across the 78 participants, a total of 2336 out of 2496 expected acceptability judgements were recorded (94%). The remaining 160 judgements (6%) were likely missed due to participants not selecting one of the ‘okay’ or ‘not okay’ options correctly before advancing. Average judgments across participants were calculated for each stem-final alternation by vowel backness and are presented in Figure 2, with each judgement coded as 0 if a participant judged the paradigm as unacceptable and 1 if they judged it acceptable.

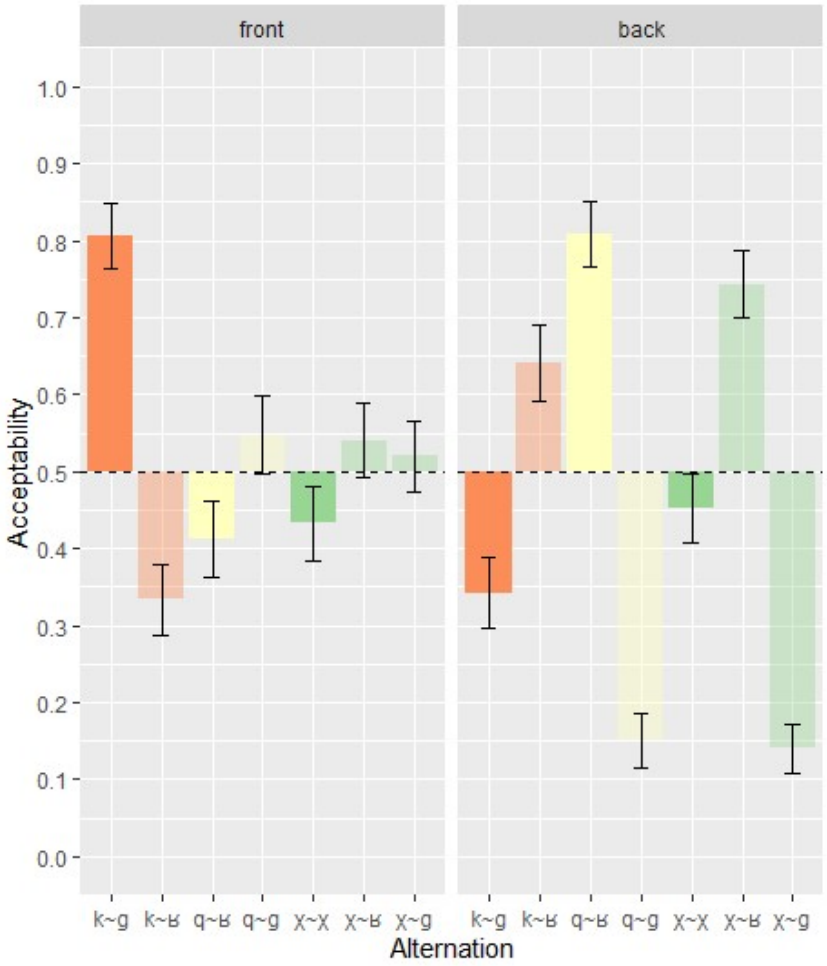

Figure 2. Mean acceptability values for stem-final dorsal alternations in front and back vowel environments

These results largely confirm a preference for grammatical over ungrammatical nonce word pairs: the alternations *k~g* with front vowels (mean 80%) and *q~ʁ* with back vowels (81%) had the highest acceptability. Nonce word pairs with a grammatical inflected member but an ungrammatical bare member were also preferred (though not as much). When one member was ungrammatical, nonce word pairs with stem-final dorsals in the inflected member matching the correct vowel environment were preferred over pairs with stem-final dorsals matching in the correct place of articulation with the bare member. That is, the alternations *q~g* with front vowels (55%) and *k~ʁ* with back vowels (65%) had higher acceptability than the alternations *q~ʁ* with front vowels (42%) and *k~g* with back vowels (34%). When judging an ungrammatical inflected member, matching the place of articulation with the bare member, even with a mismatch in the vowel environment, was preferred. As expected, mismatching the place of articulation between an ungrammatical inflected member and an grammatical bare member led to the lowest acceptability: the alternations *k~ʁ* with front vowels (34%) and *q~g* with back vowels (14%). Finally, the alternation of /X/ with itself between word-final and stem-final positions was dispreferred with front (43%) and back (45%) vowels. However, the alternation *X~ʁ* was preferred with both

vowel environments (front 54%, back 74%), and *X~g* was borderline preferred with front vowels (52%) but dispreferred with back vowels (14%).

The acceptability judgements were analysed using a mixed effect logistic regression model, with two predictors: Vowel (backness) and Alternation, and included Participant as a random effect. Vowel had two levels (front and back), and Alternation had seven levels (*k~g*, *k~ʁ*, *q~ʁ*, *q~g*, *X~X*, *X~ʁ*, and *X~g*). The model was run twice, once with front and *k~g* as the reference level and once with back and *q~ʁ* as the reference level. Changes in vowel backness or the alternation between word-final and stem-final intervocalic dorsals resulted in significant decreases in acceptability, with p-values below 0.5. The only exception was *X~ʁ* with back vowels (back and *q~ʁ* as the reference level), which was not significant ($p>0.05$). These results aligned with the mean acceptability values for different vowel backness and stem-final dorsal alternation combinations. Interactions between vowel backness and the stem-final alternation were also significant, showing better than expected performances for most changes. The exceptions were *q~g* and *X~g* with back vowels (with front and *k~g* as the reference level) and *k~ʁ* with a front vowels (with back and *q~ʁ* as the reference level), all of which were not significant ($p>0.05$).

6. Discussion. Putting /X/ aside for a moment, the results of the word judgment task indicate that participants found phonotactically licit forms to be acceptable nonce words. Specifically, nonce words ending in /k/ in front vowel environments and those ending in /q/ in back vowel environments were the only forms with above 50% acceptability. All other nonce words were generally deemed unacceptable. However, there was a gradient in acceptability on average across participants, suggesting that participants had relative preferences among competing factors. Notably, the voicing restriction appeared to carry more weight than the place of articulation restriction, that is, nonce words with word-final voicelessness were consistently judged as more acceptable than nonce words with word-final voicing, regardless of their place of articulation. Within those categories, forms conforming to the place of articulation restriction were judged more acceptable than forms that violated it. The gradient acceptability is illustrated in (7), with the lighter cells indicating acceptability results that satisfy the voicing and/or the place of articulation restrictions and darker cells indicating results that do not satisfy the voicing and/or the place of articulation restrictions.

(7) Word judgement gradient acceptability pattern

1 (best)		2		3		4 (worst)
V_{FRONT}k V_{BACK}q	>	V_{FRONT}q V_{BACK}k	>	V_{FRONT}ɡ V_{BACK}ʁ	>	V_{FRONT}ʁ V_{BACK}ɡ

satisfies voicing restriction (word-final voiceless)		violates voicing restriction (word-final voiced)	
satisfies place of articulation restriction (front-velar, back-uvular)	violates place of articulation restriction (front-uvular, back-velar)	satisfies place of articulation restriction (front-velar, back-uvular)	violates place of articulation restriction (front-uvular, back-velar)

Once again, setting /X/ aside, the results of the paradigm judgment task reveal a more fine-grained understanding of the place of articulation restriction and its interaction with paradigm uniformity. Participants showed a clear preference for paradigms that satisfied the place restriction in the bare and inflected nonce words. However, as with the word judgement task, there was gradience in acceptability on average across participants. The strongest preference was for in-

flected forms that satisfied the place of articulation restriction, even in inconsistent paradigms. In contrast, the weakest preference was for bare forms that satisfied the place of articulation restriction. The gradient acceptability is illustrated in (8), with lighter cells indicating acceptability results that satisfy the place of articulation restriction and/or have paradigm consistency, and darker cells indicating acceptability results that do not satisfy the place of articulation restriction and/or have paradigm inconsistency.

(8) Paradigm judgement gradient acceptability pattern

1 (best)		2		3		4 (worst)
V_{FRONT}k~g V_{BACK}q~ʁ	>	V_{BACK}k~ʁ V_{FRONT}q~g	>	V_{BACK}k~g V_{FRONT}q~ʁ	>	V_{FRONT}k~ʁ V_{BACK}q~g

satisfies place restriction in inflected forms (front-velar, back-uvular)		violates place restriction in inflected forms (front-uvular, back-velar)	
consistent paradigm (velar~velar, uvular~uvular)	inconsistent paradigm (velar~uvular, uvular~velar)	consistent paradigm (velar~velar, uvular~uvular)	inconsistent paradigm (velar~uvular, uvular~velar)
satisfies place restriction in bare form	violates place restriction in bare form	violates place restriction in bare form	satisfies place restriction in bare form

Now turning to /X/, the results of the word judgment task revealed that participants generally judged /X/ as unacceptable overall, with even lower acceptability in front vowel environments. Similarly, in the paradigm judgment task, participants showed a clear dispreference for the stem-final intervocalic voiceless alternant [X]. Among the voiced alternants, [ʁ] was generally favoured over [g], indicating that /X/ is perceived as aligning more closely with uvulars than with velars. The couple of pieces of evidence supporting the idea that /X/ behaves more like a uvular are (1) its word-final realisation in back vowel environments was rated slightly less unacceptable (i.e., closer to chance levels), and (2) its considerably higher above-chance acceptability when alternating with stem-final intervocalic [ʁ], when considering that its exact place of articulation and whether it has a stem-final intervocalic voiced alternant is unclear.

Interestingly, participants accepting the alternation between [X] and [ʁ], even though it is unclear whether it occurs in native Kazakh, may reflect an emergence of the unmarked effect (McCarthy & Prince 1994). A generally marked /X/ may be avoided in the stem-final intervocalic position, causing a complementary, unmarked [ʁ] to emerge in this context.

The fact that [X] receives higher acceptability when alternating with [ʁ] (and to a lesser extent with [g]), compared to when [X] alternated with itself across nonce word forms, suggests that intervocalic voicing is a productive process that extends even to the non-native /X/ found in Kazakh loanwords. The alternation between word-final voiceless dorsals and stem-final intervocalic voiced dorsals is well-documented in Kazakh phonology (Bekturova & Bekturov 1996; Kara 2002; Muhamedowa 2016). Importantly, the morphological boundary appears to serve as the conditioning environment for the voicing alternation, that is, participants preferred [X] alternating with a voiced intervocalic form, supporting the idea that the voicing process can be analysed as a derived-environment effect, where intervocalic voicing is restricted to morpheme boundaries, and thus morphologically conditioned (see Burzio 2011; Hall 2006; Kula 2008).

The results also reveal interesting morphophonological facts involving stem-final segments and their interaction with affixation. In the word judgment task, only the nonce words that satis-

fied both the voicing and place of articulation restrictions received above chance acceptability (e.g. word-final [k] in front vowel environments and word-final [q] in back vowel environments. However, among the nonce words judged as unacceptable, participants showed a clear preference towards favouring word-final voiceless dorsals that violated the place of articulation restriction (e.g. word-final [q] in front vowel environments and [k] in back vowel environments) over word-final voiced dorsals that satisfied the place of articulation restriction (e.g. word-final [ɡ] in front vowel environments and [ʁ] in back vowel environments). The nonce words violating both restrictions had the lowest acceptability.

Turning to the paradigm judgment task, the results suggest that even if a bare nonce stem is exceptional, affixation with regular morphology can override or mask that exceptionality (see Jurgec 2012; Jurgec & Bjorkman 2018; Zuraw 2000). Paradigms that are consistent and satisfy the place of articulation restriction have the highest acceptability (e.g. [k] word-finally with [ɡ] intervocalically in front vowel environments and [q] word-finally with [ʁ] intervocalically in back vowel environments). Among the paradigms that violate the place of articulation restriction, inconsistent paradigms that violate the restriction in the bare form but satisfy it in the inflected form (e.g. [q] word-finally with [ɡ] intervocalically in front vowel environments; or [k] word-finally with [ʁ] intervocalically in back vowel environments) were preferred over consistent paradigms that violate the restriction in both bare and inflected forms (e.g. [k] word-finally with [ɡ] intervocalically in back vowel environments and [q] word-finally with [ʁ] intervocalically in front vowel environments). The least acceptable were paradigms that satisfy the restriction in the bare form but violate it in the inflected form. This pattern may be captured within an Optimality Theory framework (McCarthy & Prince 1993; Prince & Smolensky 2004) by allowing constraints to be indexed specifically to loanwords (see Itô & Mester 2001).

Another interesting issue that came from both judgment tasks is the gradient nature of acceptability and its implications for theoretical analysis. The data shows that among illicit forms, some are consistently judged to be more acceptable than others. One plausible explanation is that Kazakh speakers are accessing underlying constraint hierarchies in their acceptability judgments—rankings that may not surface in actual production. In other words, speakers may rely on abstract grammatical knowledge that influences perception but does not manifest in spoken language. This suggests that constraint ranking plays a role not only in production but also in comprehension and evaluation. While Optimality Theory has traditionally focused on output forms that emerge from optimal constraint satisfaction, these findings point to a broader role for constraint interaction—one that extends into the perceptual domain, even when it leaves no trace in production.

7. Conclusion. This study offers key insights into the phonological behaviour of Kazakh dorsal obstruents, highlighting how acceptability judgments interact with morphology. Kazakh velars and uvulars show gradience in acceptability, whereby illicit combinations are dispreferred across all participants, but are not outright ungrammatical. Additionally, /X/ is generally dispreferred, especially where a voiced counterpart is expected. Participants favoured its alternation with [ʁ], suggesting a preference for consistent manner of articulation. The results contribute to our understanding of Kazakh phonology and demonstrate how morphology, perception, and the distinction between native and loanword phonotactics shape acceptability.

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