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Turkic Nasal Harmony as Surface Correspondence

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Abstract

Turkic languages are well known for syllable contact phenomena – sonority-driven processes where suffix-initial sonorants surface as obstruents in certain environments. These alternations interact with nasal harmony, a less studied phenomenon where underlying stops and nasals surface as nasals between two nasals. Nasal harmony is attested in about ten Turkic languages (Shor, various Khakas varieties, northern and southern Altay varieties, Kazakh, Qaraqalpaq, Noghay, possibly Karachay-Balkar, and Kazan and Siberian Tatar varieties), and it varies in its scope and how it interacts with syllable contact phenomena. In this paper, we provide a detailed description of nasal harmony in Kazakh, which has one of the richest nasal harmony systems, and explore an analysis within Surface Correspondence Theory.

Turkic Nasal Harmony as Surface Correspondence

Andrew Lamont and Jonathan North Washington[*]

1 Introduction

Turkic languages are well known for syllable contact phenomena – sonority-driven processes where suffix-initial sonorants surface as obstruents in certain environments (Baertsch and Davis 2001, 2004, Gouskova 2004, Washington 2010). For example, the underlying nasal in the Kazakh accusative suffix /-nI/ surfaces as [n] following vowels as in [ɑɫmɑ-nə] 'apple-ACC', and as [d] after consonants as in [qɑn-də] 'blood-ACC'. These alternations interact with *nasal harmony*, a less studied phenomenon where underlying stops and nasals surface as nasals between two nasals (Eulenberg 1996, Davis 1998). For example, the underlying stop in the Kazakh ablative suffix /-dAn/ surfaces as [n] after nasals as in [qɑn-nɑn] 'blood-ABL', and as [d] elsewhere as in [ɑɫmɑ-dɑn] 'apple-ABL'.

Nasal harmony is attested in about ten Turkic languages (Shor, various Khakas varieties, northern and southern Altay varieties, Kazakh, Qaraqalpaq, Noghay, possibly Karachay-Balkar, and Kazan and Siberian Tatar varieties), and it varies in its scope and how it interacts with syllable contact phenomena (Anderson 2005, Washington 2010). In this paper, we provide a detailed description of nasal harmony in Kazakh, which has one of the richest nasal harmony systems, and explore an analysis within Surface Correspondence Theory (Bennett 2013, 2015b). This analysis extends readily to the other languages. The paper is organized as follows: Section 2 gives representative data from Kazakh, Section 3 presents our analysis, and Sections 4 and 5 discuss the analysis and conclude.

2 Nasal Harmony in Kazakh

This section provides data from Kazakh. Transcriptions do not include aspiration and certain other irrelevant subphonemic details. Data are drawn from fieldwork by the second author and have been verified in printed materials and corpus searches. The basic generalizations are: suffixes of the shape /-NV/[1] and /-DV/ surface as [-DV] after nasal-final stems due to sonority restrictions, and suffixes of the shape /-NVN/ and /-DVN/ with final nasals surface as [-NVN] after nasal-final stems, unless phonotactic restrictions block nasalization or certain locality conditions are not met.

2.1 Syllable Contact Effects

In Kazakh, the surface form of initial consonants in /-CV/ suffixes is primarily determined by the preceding segment. Sonority falls are preferred to plateaus and rises across syllable boundaries, and underlying sonorants accordingly surface as stops to avoid dispreferred clusters; Table 1 gives examples. Underlying stops surface as stops in all contexts, as in the locative suffix /-dA/ (1a).

		a. /-dA/ 'LOC'	b. /-nI/ 'ACC'	c. /mA/ 'INT'[2]	d. /-lI/ 'ADJ'
/ɑlmɑ/	'apple'	[ɑɫmɑ-dɑ]	[ɑɫmɑ-nə]	[ɑɫmɑ mɑ]	[ɑɫmɑ-ɫə]
/qɑr/	'snow'	[qɑr-dɑ]	[qɑr-də]	[qɑr mɑ]	[qɑr-ɫə]
/gʉl/	'flower'	[gʉl-diɘ]	[gʉl-də]	[gʉl miɘ]	[gʉl-də]
/qɑn/	'blood'	[qɑn-dɑ]	[qɑn-də]	[qɑn bɑ]	[qɑn-də]
/qɑz/	'goose'	[qɑz-dɑ]	[qɑz-də]	[qɑz bɑ]	[qɑz-də]

Table 1: Desonorization at root-suffix junctures in Kazakh. Horizontal lines separate sonorant-initial allomorphs (above) from stop-initial allomorphs (below).

[*]For comments and discussion, we are grateful to the audience at PLC 42, especially Jeff Mielke, three anonymous reviewers for PLC, and Joe Pater. All remaining errors are of course our own.

[1]C = consonant, V = vowel, N = nasal, D = stop, A = "low" vowel, I = "high" vowel, G = voiced dorsal obstruent. Surface forms of underlying A, I, and G are predictable from backness harmony and other factors.

[2]We follow the orthographic convention of representing the interrogative as a separate word in Kazakh.

Underlying /n/ only surfaces as [n] after vowels, and desonorizes to [d] after all consonants, as in the accusative suffix /-nI/ (1b). All other underlying sonorants surface as stops after consonants of equal or lower sonority, and as sonorants otherwise, as in the interrogative suffix /mA/ (1c) and the adjectival suffix /-lI/ (1d).

2.2 Nasal Harmony

Suffixes of the shape /-DVN/ and /-NVN/ behave largely like /-DV/ and /-NV/ suffixes with respect to syllable contact phenomena. Table 2 gives the ablative /-dAn/, genitive /-nIŋ/, and instrumental /-miən/ forms of the stems in Table 1. These case suffixes are nasal-final, (near-) minimal counterparts of the locative, accusative, and interrogative suffixes, respectively. For the most part, they surface with initial stops exactly where expected according to sonority restrictions (below the horizontal lines). However, they deviate with the nasal-final /qɑn/ 'blood', surfacing with initial nasals. These forms (bolded) exemplify nasal harmony. Only nasal-final suffixes subvert sonority restrictions in this way in Kazakh; the initial laterals of the plural suffix /-lAr/ (2d) and the adjectival suffix /-lI/ (1d) desonorize in exactly the same environments as each other. Nasal harmony does not only apply to case suffixes; the first person singular copular suffix /-mIn/ also undergoes nasal harmony.

		a. /-dAn/ 'ABL'	b. /-nIŋ/ 'GEN'	c. /-miən/ 'INS'	d. /-lAr/ 'PL'
/ɑlmɑ/	'apple'	[ɑɫmɑ-dɑn]	[ɑɫmɑ-nəɴ]	[ɑɫmɑ-miən]	[ɑɫmɑ-ɫɑr]
/qɑr/	'snow'	[qɑr-dɑn]	[qɑr-dəɴ]	[qɑr-miən]	[qɑr-ɫɑr]
/gʉl/	'flower'	[gʉl-diən]	[gʉl-dəŋ]	[gʉl-miən]	[gʉl-diər]
/qɑn/	'blood'	**[qɑn-nɑn]**	**[qɑn-nəɴ]**	**[qɑn-miən]**	[qɑn-dɑr]
/qɑz/	'goose'	[qɑz-dɑn]	[qɑz-dəɴ]	[qɑz-biən]	[qɑz-dɑr]

Table 2: Desonorization and nasal harmony at root-suffix junctures in Kazakh.

These alternations also occur at suffix-suffix junctures, as Table 3 illustrates with the nasal-final possessive suffixes /-Im/ and /-Iŋ/ (compare forms of /qɑn/ 'blood' above). /-DV/ and /-NV/ suffixes surface with initial stops (3a-c), and /-DVN/ and /-NVN/ suffixes surface with initial nasals (3d-f). As above, forms exhibiting nasal harmony are bolded.

	/qɑz-Im/ → [qɑz-əm] 'goose-POSS.1SG'	/qɑz-Iŋ/ → [qɑz-əɴ] 'goose-POSS.2SG'
a. /-dA/ 'LOC'	[qɑz-əm-dɑ]	[qɑz-əɴ-dɑ]
b. /-nI/ 'ACC'	[qɑz-əm-də]	[qɑz-əɴ-də]
c. /mA/ 'INT'	[qɑz-əm bɑ]	[qɑz-əɴ bɑ]
d. /-dAn/ 'ABL'	**[qɑz-əm-nɑn]**	**[qɑz-əɴ-nɑn]**
e. /-nIŋ/ 'GEN'	**[qɑz-əm-nəɴ]**	**[qɑz-əɴ-nəɴ]**
f. /-miən/ 'INS'	**[qɑz-əm-miən]**	**[qɑz-əɴ-miən]**

Table 3: Desonorization and nasal harmony at suffix-suffix junctures in Kazakh.

No suffixes that attach directly to verbs are the right shape to undergo nasal harmony. However, some forms of verbs, such as /bɑr-GAn/ → [bɑr-ʁɑn] 'go-GER/PAST.REM', do take suffixes that

a. /-sIŋ/	/siən-sIŋ/	[siən-səŋ]	*[**siən-nəŋ**]	'you-COP.NPST.2.SG'
'COP.NPST.2.SG'	/χɑnəm-sIŋ/	[χɑnəm-səɴ]	*[**χɑnəm-nəɴ**]	'lady-COP.NPST.2.SG'
b. /-sIn/	/qɑn-sIn/	[qɑn-sən]	*[**qɑn-nən**]	'quench-OPT.3'
'OPT.3'	/ʒiəŋ-sIn/	[ʒiəŋ-sən]	*[**ʒiəŋ-nən**]	'be.victorious-OPT.3'
c. /-sA/	/qɑn-sA/	[qɑn-sɑ]		'quench-COND'
'VADV.COND'	/ʒiəŋ-sA/	[ʒiəŋ-siə]		'be.victorious-COND'

Table 4: Nasal harmony does not target fricatives in Kazakh.

undergo nasal harmony: /bɑr-GAn-miən/ → **[bɑr-ʁɑn-miən]** 'go-GER-INS', /bɑr-GAn-dAn/ → **[bɑr-ʁɑn-nɑn]** 'go-GER-ABL', /bɑr-GAn-mIn/ → **[bɑr-ʁɑn-mən]** 'go-PAST.REM-1SG'.

Only underlying stops and nasals undergo nasal harmony; fricatives do not, as Table 4 above illustrates. After nasals, the initial fricatives of the second person singular informal copular suffix /-sIŋ/ (4a) and the third person optative suffix /-sIn/ (4b) surface faithfully. This is true of fricative-initial suffixes in general, as forms with the conditional verbal adverb suffix /-sA/ (4c) illustrate.

2.3 Conditions on Nasal Harmony

As Section 2.2 demonstrated, onset stops and nasals surface as nasals between coda nasals, overriding phonotactic pressures for sonority to fall across syllable boundaries. Nasal harmony is itself overridden by other phonotactic restrictions. Dorsal nasals are dispreferred onsets, and nasal harmony is blocked from creating them, as Table 5 illustrates with the remote past tense suffix /-GAn/. The initial dorsal surfaces as a stop even between two nasals, the environment for nasal harmony.[3]

/-GAn/	a. /siən-GAn/	[siəŋ-giən]	***[siəŋ-ŋiən]**	'believe-PAST.REM'
'PAST.REM'	b. /ʊsən-GAn/	[ʊsəɴ-ɢɑn]	***[ʊsəɴ-ɴɑn]**	'offer-PAST.REM'

Table 5: Nasal harmony does not target dorsals in Kazakh.

Kazakh avoids rising sonority clusters, and blocks nasal harmony from creating them, as Table 6 illustrates. Stems with final nasal-stop clusters do not trigger nasal harmony with /-DVN/ and /-NVN/ suffixes, as in /ɑnt-nIŋ/ → [ɑnt-təɴ] ***[ɑnt-nəɴ]** 'oath-GEN'. These stems behave identically to stop-final stems like /ɑt/ 'horse'. Despite appearing between two nasal codas, suffix-initial segments surface as stops after stems with final nasal-stop clusters.

	/ɑt/ 'horse'	/ɑnt/ 'oath'		/dɑɴq/ 'glory'	
a. /-dA/ 'LOC'	[ɑt-tɑ]	[ɑnt-tɑ]		[dɑɴq-tɑ]	
b. /-nI/ 'ACC'	[ɑt-tə]	[ɑnt-tə]		[dɑɴq-tə]	
c. /mA/ 'INT'	[ɑt pɑ]	[ɑnt pɑ]		[dɑɴq pɑ]	
d. /-dAn/ 'ABL'	[ɑt-tɑn]	[ɑnt-tɑn]	***[ɑnt-nɑn]**	[dɑɴq-tɑn]	***[dɑɴq-nɑn]**
e. /-nIŋ/ 'GEN'	[ɑt-təɴ]	[ɑnt-təɴ]	***[ɑnt-nəɴ]**	[dɑɴq-təɴ]	***[dɑɴq-nəɴ]**
f. /-miən/ 'INS'	[ɑt-piən]	[ɑnt-piən]	***[ɑnt-miən]**	[dɑɴq-piən]	***[dɑɴq-miən]**

Table 6: Nasal-stop clusters do not trigger nasal harmony in Kazakh.

This blocking is more pronounced in Turkic languages that do allow rising sonority clusters, such as (Kazan) Tatar. As Table 7 illustrates, Tatar does not enforce sonority restrictions as strictly as Kazakh. Sonorants surface faithfully in rising sonority clusters, as in [ɒt-nə] 'horse-ACC' and [ɒnt-nəɴ] 'oath-GEN'. Sonority-driven desonorization is not active in Tatar, so the only unambiguous case of nasal harmony comes from the ablative suffix /-dAn/, which surfaces with an initial nasal after nasal-final stems, as in /qɒn-dAn/ → **[qɒn-nɑn]** 'blood-ABL' (compare /qɒn-dA/ → [qɒn-dɑ] 'blood-LOC'). Crucially, even though Tatar allows rising sonority clusters, nasal harmony is blocked from creating them: /ɒnt-dAn/ → [ɒnt-tɑn] ***[ɒnt-nɑn]** 'oath-ABL'.

		a. /-dA/ 'LOC'	b. /-dAn/ 'ABL'	c. /-nI/ 'ACC'	d. /-nIŋ/ 'GEN'
/ɒlmɑ/	'apple'	[ɒɫmɑ-dɑ]	[ɒɫmɑ-dɑn]	[ɒɫmɑ-nə]	[ɒɫmɑ-nəɴ]
/qɒr/	'snow'	[qɒr-dɑ]	[qɒr-dɑn]	[qɒr-nə]	[qɒr-nəɴ]
/gʏl/	'flower'	[gʏl-dæ]	[gʏl-dæn]	[gʏl-nə]	[gʏl-nəŋ]
/qɒn/	'blood'	[qɒn-dɑ]	**[qɒn-nɑn]**	[qɒn-nə]	[qɒn-nəɴ]
/ɒnt/	'oath'	[ɒnt-tɑ]	[ɒnt-tɑn]	[ɒnt-nə]	[ɒnt-nəɴ]
/ɒt/	'horse'	[ɒt-tɑ]	[ɒt-tɑn]	[ɒt-nə]	[ɒt-nəɴ]

Table 7: Nasal harmony in Kazan Tatar.

[3] Whether dorsal stops surface as velar or uvular depends on backness harmony in the word.

3 Analysis of Nasal Harmony in Kazakh

This section presents an analysis of Kazakh nasal harmony as a long-distance interaction between coda nasals. This is couched within Surface Correspondence Theory (Bennett 2013, 2015b), a framework for analyzing long-distance phenomena in Optimality Theory (Prince and Smolensky 1993/2004). Like other Agreement By Correspondence frameworks (Hansson 2001, 2010, Rose and Walker 2004), Surface Correspondence Theory posits that segments in a candidate may be compelled to belong to correspondence classes, and that constraints on corresponding segments can compel featural agreement. This is exactly like input-output correspondence (McCarthy and Prince 1995), except that the relations are between segments in a given output candidate, rather than between segments in the underlying and surface representations.

The basic analysis holds that nasals in coda position are compelled to correspond with each other. Correspondence is restricted such that only nasals in adjacent syllables with the same syllable role (i.e., coda) enter into correspondence. There is an additional pressure for correspondence classes to include intervening segments specified as [−continuant]; this requires onset stops and nasals to correspond with surrounding coda nasals. Corresponding segments are pressured to agree in nasality. In the case of underlying stops, this pressure triggers nasalization, and, in the case of underlying nasals, it prevents sonority-driven desonorization.

The constraint rankings argued for in our analysis are summarized in the Hasse diagram in Figure 1. Most of the constraints used in the analysis are standard, and are discussed as they appear in tableaux. Below, we provide detailed definitions for the three constraints that are unique to our analysis: SYLLABLECONTACT, CORR-WORD[NASAL,CODA], and NOGAP[−CONTINUANT].

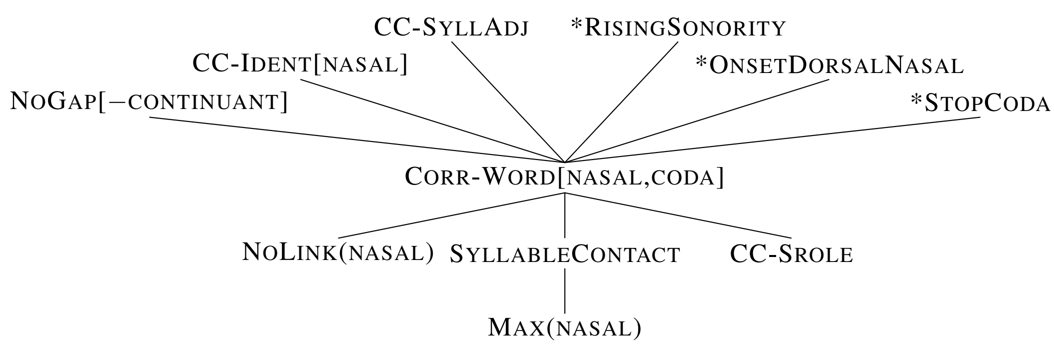

Figure 1: Hasse diagram for Kazakh.

To motivate syllable contact effects, we use two ad hoc markedness constraints: SYLLABLE-CONTACT and *RISINGSONORITY. The former is simply a cover constraint that lists the environments for desonorization in Kazakh: biconsonantal heterosyllabic clusters ending with [n] and those that end in sonorants and do not fall in sonority. *RISINGSONORITY simply penalizes rising sonority clusters. These are split into two constraints to avoid ranking paradoxes. The constraints suffice for our purposes, but are not intended as a complete analysis. Syllable contact in Turkic languages is a nuanced subject whose treatment far exceeds the scope of this paper (see Davis 1998, Baertsch and Davis 2001, 2004, Gouskova 2004, Washington 2010, Zhu 2018 for various approaches).

SYLLABLECONTACT Assign one violation for every heterosyllabic consonant cluster C_1C_2, where C_2 is [n], or C_2 is a sonorant and C_1 is not higher in sonority.

To motivate correspondence between coda nasals, we use the CORR constraint CORR-WORD [NASAL,CODA]. CORR constraints specify a domain and a set of features, and require that all consonants in that domain with those features belong to a correspondence class (see Bennett 2015b:40-51 for detailed discussion). Because correspondence holds between nasals in the stem and in a suffix, the domain is the morphological word. The set of features includes both a phonological feature (nasal) and a syllable position (coda); this is unusual, but necessary to model the data successfully.

Corr-Word[nasal,coda] Assign one violation for each pair of consonants X and Y in the same word if (1) X and Y are both nasal, (2) X and Y are both codas, and (3) X and Y do not belong to the same correspondence class.

Corr-Word[nasal,coda] only demands that nasal codas belong to the same correspondence class. Crucially, this excludes the targets of nasal harmony, which are always in onset position, and, in the case of the ablative suffix /-dAn/, may not be underlyingly nasal. Further, because correspondence between onsets and codas violates the constraint CC-SRole (Bennett 2015b:58-61), there must be a constraint that compels certain onsets to correspond with surrounding nasal codas. To that end, we use the constraint NoGap[−continuant], which requires that correspondence classes include intervening [−continuant] consonants.

NoGap[−continuant] Assign one violation for every consonant X specified as [−continuant] if (1) there is a consonant Y to the left of X, (2) there is a consonant Z to the right of X, (3) Y and Z belong to the same correspondence class, (4) Y and Z are both [−continuant], and (5) X does not belong to that correspondence class.

For any given set of consonants, there is a large number of possible correspondence classes (Bennett 2015b:21-25), and a large number of logically possible candidates. To save space, we only discuss candidates whose correspondence classes include consonants in the suffix and stem-final consonants, unless otherwise stated. Segments that belong to the same correspondence class are underlined. With certain exceptions, Kazakh disallows changing stem consonants; we assume high-ranking stem-faithfulness and do not consider candidates with unfaithful stem consonants.[4]

3.1 Syllable Contact Effects

Syllable contact effects are motivated by ranking the markedness constraint SyllableContact over Max(nasal), which penalizes deleting underlying nasal features. Tableau 1 illustrates this with /qɑn-nI/ → [qɑn-də] 'blood-acc'. Candidates with nasal-nasal clusters violate Syllable-Contact (1a-b), and are dispreferred to candidates where the nasal feature has been deleted from the suffix (1c-d). Crucially, the suffix nasal cannot initiate correspondence. Correspondence between an onset and a coda violates CC-SRole, and, when the nasal feature has deleted, CC-Ident[nasal] (Bennett 2015b:52-53), which requires corresponding segments to agree in nasality. CC-SRole and CC-Ident[nasal] are *CC-Limiter* constraints, so-called because they limit correspondence classes.

/qɑn-nI/	CC-Ident [nasal]	Corr-Word [nasal,coda]	CC-SRole	Syll Con	Max (nas)
a. qɑn-nə				W1	L
b. qɑn̲-n̲ə			W1	W1	L
→ c. qɑn-də					1
d. qɑn̲-d̲ə	W1		W1		1

Tableau 1: /qɑn-nI/ → [qɑn-də] 'blood-acc'.

3.2 Nasal Harmony

Correspondence does play an active role with suffixes of the shape /-DVN/ and /-NVN/, as Tableau 2 illustrates with /qɑn-dAn/ → [qɑn-nɑn] 'blood-abl' below. The constraint Corr-Word[nasal, coda] requires that the nasal codas belong to the same correspondence class, however it is dominated by constraints that impose restrictions on correspondence. NoGap[−continuant] requires that the intervening stop belong to the same correspondence class, ruling out gapped configurations

[4]Here we use *stem* to refer to the base of affixation – which includes morphemes incorporated via earlier affixation – not any specific morphological category.

/qɑn-dAn/	NoGap [−cont]	CC-Ident [nasal]	Corr-Word [nasal,coda]	CC-SRole	Syll Con	No Link
a. qɑn-dɑn			W1	L	L	L
b. qɑn̲-dɑn̲	W1			L	L	L
c. qɑn̲-d̲ɑn̲		W2		2	L	L
d. qɑn-nɑn			W1	L	1	1
e. qɑn̲-nɑn̲	W1			L	1	1
→ f. qɑn̲-n̲ɑn̲				2	1	1

Tableau 2: /qɑn-dAn/ → [qɑn-nɑn] 'blood-abl' (one of two).

(2b,e). This conflicts with the demands of CC-SRole, which is lower ranked. CC-Ident[nasal] requires correspondents agree in nasality, ruling out faithful candidates (2c). This crucially conflicts with the lower ranked SyllableContact, which disprefers nasal-nasal clusters. The optimal candidate (2f) violates these lower ranked constraints as well as NoLink(nasal) – which penalizes spreading nasal features (McCarthy 2008) – but satisfies the Corr and CC-Limiter constraints.

Because Tableau 2 only includes unfaithful candidates where the initial consonant of the suffix has changed, it excludes a particularly problematic candidate. As Tableau 3 illustrates with the same input, deleting the nasal feature from the ablative suffix /-dAn/ not only satisfies the Corr constraint by reducing the number of coda nasals to 1, but it also satisfies SyllableContact by avoiding a nasal-nasal cluster (3b). We use a constraint against stops surfacing in coda position *StopCoda to rule out this candidate. This constraint also blocks denasalization when a potential target of nasal harmony is shielded by stem faithfulness, as in /pɑndɑ-Im/ → [pɑndɑ-m] *[pɑndɑ-b] *[**pɑnnɑ-m**] 'panda-poss.1sg' (recent borrowing).[5] Provided *StopCoda is ranked below Dep(nasal), it cannot motivate spontaneous nasalization of codas. This is a welcome state of affairs, as Kazakh does allow stop codas, such as /ɑt/ → [ɑt] 'horse'. Aside from the spacing problem posed by the additional constraints, we provide separate tableaux for /qɑn-dAn/ for one important reason: to our knowledge no previous analysis of these data has considered candidates like *[qɑn-dɑd] (Eulenberg 1996, Davis 1998, Washington 2010, Kuhn 2014).

/qɑn-dAn/	*Stop Coda	Corr-Word [nasal,coda]	CC-SRole	Syll Con	No Link	Max (nas)
a. qɑn-dɑn		W1	L	L	L	
b. qɑn-dɑd	W1		L	L	L	W1
→ c. qɑn̲-n̲ɑn̲			2	1	1	

Tableau 3: /qɑn-dAn/ → [qɑn-nɑn] 'blood-abl' (two of two).

The behavior of fricative-initial suffixes is accounted for by NoGap[−continuant], as

/qɑn-sIn/	NoGap [−cont]	CC-Ident [nasal]	Corr-Word [nasal,coda]	CC-SRole	Syll Con	No Link
a. qɑn-sən			W1			
→ b. qɑn̲-sən̲						
c. qɑn̲-s̲ən̲		W2		W2		
d. qɑn-nən			W1		W1	W1
e. qɑn̲-nən̲	W1				W1	W1
f. qɑn̲-n̲ən̲				W2	W1	W1

Tableau 4: /qɑn-sIn/ → [qɑn-sən] 'quench-opt.3'.

[5] Additionally, stem faithfulness extends to affixes that have already been incorporated, as in /siən-dI-ŋ/ → [siən-diə-ŋ] ***[siən-niə-ŋ]** 'believe-past.rcnt.eyewit-2.sg'. This was first observed by Washington (2010) and suggests a cyclic interaction between affixation and phonology which we plan to return to in future work.

Tableau 4 illustrates with /qɑn-sIn/ → [qɑn-sən] 'quench-OPT.3'. Because this constraint only forbids correspondence classes from skipping over [−continuant] consonants, there is no pressure for fricatives to correspond. Correspondence between nasals and stops violates CC-IDENT[NASAL] and correspondence between onsets and codas violates CC-SROLE. Because no constraints conflict with these, the candidate where only the coda nasals correspond (4b) wins by harmonic bounding.

Suffix-initial dorsals are blocked from undergoing nasal harmony by a constraint against dorsal nasals in onset position *ONSETDORSALNASAL. This is illustrated in Tableau 5 with /siən-GAn/ → [siəŋ-giən] 'believe-PAST.REM'. Unlike in Tableau 4, gapped correspondence is non-optimal (5b,e). This is because NOGAP[−CONTINUANT] requires stops to participate in correspondence. Including the dorsal stop in the correspondence class violates CC-IDENT[NASAL] (5c), and nasalization violates *ONSETDORSALNASAL (5d-f). This leaves the faithful candidate without any correspondence class as optimal (5a). The analysis predicts that dorsals surface as oral between nasals whether they are [+continuant] as in Tableau 4, or [−continuant] as in Tableau 5.

/siən-GAn/	NOGAP [−CONT]	CC-IDENT [NASAL]	*ONSET DORSNAS	CORR-WORD [NASAL,CODA]	CC-SROLE
→ a. siəŋ-giən				1	
b. siəŋ̲-giən̲	W1			L	
c. siəŋ̲-g̲iən̲		W2		L	W2
d. siəŋ-ŋiən			W1	1	
e. siəŋ̲-ŋiən̲	W1		W1	L	
f. siəŋ̲-ŋ̲iən̲			W1	L	W2

Tableau 5: /siən-GAn/ → [siəŋ-giən] 'believe-PAST.REM'.

Blocking by markedness similarly accounts for stems with final nasal-stop clusters. The constraint against rising sonority clusters *RISINGSONORITY, which, like *ONSETDORSALNASAL, dominates the CORR constraint, prevents stems with final nasal-stop clusters from triggering nasal harmony, as in /ɑnt-nIŋ/ → [ɑnt-təɴ] ***[ɑnt-nəɴ]** 'oath-GEN'. To save space, we do not show this.

3.3 Limiting Correspondence

Nasal harmony only applies between nasal codas in adjacent syllables. Table 8 gives examples where this environment is not met. Stems with nasal codas only in the penultimate syllable do not trigger nasal harmony, as in /dɑmbɑl-dAn/ → [dɑmbɑɫ-dɑn] ***[dɑmbɑɫ-nɑn]** 'pantalettes-ABL'. Onset nasals in adjacent syllables likewise do not trigger nasal harmony, as in /mɑl-dAn/ → [mɑɫ-dɑn] ***[mɑɫ-nɑn]** 'livestock-ABL'.

	/dɑmbɑl/ 'pantalettes'		/mɑl/ 'livestock'	
a. /-dA/ 'LOC'	[dɑmbɑɫ-dɑ]		[mɑɫ-dɑ]	
b. /-nI/ 'ACC'	[dɑmbɑɫ-də]		[mɑɫ-də]	
c. /-dAn/ 'ABL'	[dɑmbɑɫ-dɑn]	***[dɑmbɑɫ-nɑn]**	[mɑɫ-dɑn]	***[mɑɫ-nɑn]**
d. /-nIŋ/ 'GEN'	[dɑmbɑɫ-dəɴ]	***[dɑmbɑɫ-nəɴ]**	[mɑɫ-dəɴ]	***[mɑɫ-nəɴ]**

Table 8: Conditions on nasal harmony in Kazakh.

In the analysis, these conditions follow from restrictions on correspondence. CORR-WORD [NASAL,CODA] requires *all* nasal codas in a word to correspond. Correspondence between non-adjacent syllables is prevented by ranking the CC-Limiter constraint CC-SYLLADJ above the CORR constraint. This is illustrated in Tableau 6 below with /dɑmbɑl-nIŋ/ → [dɑmbɑɫ-dəɴ] 'pantalettes-GEN'. CC-SYLLADJ requires that members of a correspondence class belong to a contiguous chain of syllables (Bennett 2015b:61-70). Candidates where the suffix nasals correspond with the nasal in the initial syllable [dɑm] violate CC-SYLLADJ (6b,f) because there are no corresponding nasals in the intervening syllable [bɑɫ]. This violation can be avoided by including the intervening stop in the

/dɑmbɑl-nIŋ/	CC-IDENT [NASAL]	CC-SYLL ADJ	*STOP CODA	CORR-WORD [NASAL,CODA]	CC-SROLE	SYLL CON
a. dɑmbɑɫ-nəɴ				1		W1
b. dɑm̲bɑɫ-n̲əɴ̲		W2		L	W2	W1
c. dɑm̲b̲ɑɫ-n̲əɴ̲	W3			L	W4	W1
d. dɑmbɑɫ-nəɢ			W1	L		W1
→ e. dɑmbɑɫ-dəɴ				1		
f. dɑm̲bɑɫ-d̲əɴ̲	W2	W2		L	W2	

Tableau 6: /dɑmbɑl-nIŋ/ → [dɑmbɑɫ-dəɴ] 'pantalettes-GEN'.

correspondence class, but doing so fatally introduces more violations of CC-IDENT[NASAL] (6c). If the stem contained a medial nasal-nasal cluster, correspondence between the coda nasals would be able to bridge the intervening syllable without violating CC-IDENT[NASAL] or CC-SYLLADJ. In that case, the analysis does predict that nasal harmony would apply, e.g., */dɑmnɑl-nIŋ/ → [dɑm̲nɑɫ-n̲əɴ̲]. However, this is difficult to verify in the lexicon. Native stems with medial nasal-nasal clusters (or other marked sonority profiles) are exceedingly rare if not unattested, due to diachronic changes. For example, one common form of the name *Muhammad* is pronounced with a medial nasal-stop cluster as [mʊχɑmbiət].

Onset nasals fail to trigger nasal harmony because correspondence is unmotivated. This is illustrated in Tableau 7 with /mɑl-nIŋ/ → [mɑɫ-dəɴ] 'livestock-GEN'. As in Tableau 1, because there is no general pressure for *all* nasals to correspond, correspondence between onsets cannot override SYLLABLECONTACT, and corresponding with the coda nasal violates CC-SROLE (7b).

/mɑl-nIŋ/	CC-IDENT [NASAL]	*STOP CODA	CORR-WORD [NASAL,CODA]	CC-SROLE	SYLL CON	MAX (NAS)
a. mɑɫ-nəɴ					W1	L
b. m̲ɑɫ-n̲əɴ̲				W2	W1	L
c. mɑɫ-nəɢ		W1			W1	1
→ d. mɑɫ-dəɴ						1
e. m̲ɑɫ-d̲əɴ̲	W1			W2		1

Tableau 7: /mɑl-nIŋ/ → [mɑɫ-dəɴ] 'livestock-GEN'.

4 Discussion

As laid out in Section 3, our analysis is couched within Surface Correspondence Theory (Bennett 2013, 2015b), and relies as much as possible on existing constraints. However, our CORR constraint diverges in its reference to both the phonological feature [nasal] as well as the syllable position *coda*. This is unusual, but not entirely novel. To model liquid dissimilation in Sundanese, Hansson (2001:365-374) employed a CORR constraint that requires correspondence only between liquids in adjacent syllable onsets: CORR-$[\text{LAT}]_{\text{ONS}(\sigma1\text{-}\sigma2)}$. This was crucial to account for that fact that the plural infix /-ar-/ surfaces with a final rhotic in words with rhotic onsets, as in /-ar-curiga/ → [c-ar-uriga] 'suspicious-PL', and with a final lateral elsewhere, as in /-ar-biŋgar/ → [b-al-iŋhar] 'rich-PL' (Hansson 2001:366). In the former, correspondence between the onset rhotics prevents dissimilation, and the latter, there is no pressure for the rhotics to correspond. In later work, however, Hansson (2010:281-289) reanalyzed the data using a more general CORR constraint and CC-SROLE to penalize correspondence between an onset and a coda (Bennett 2015a likewise uses CC-SROLE).

Separating these pressures into two constraints works for Sundanese, partially because the infix's liquid predictably surfaces in onset position. This is not the case for Turkic nasal harmony, which targets suffixes containing both an onset and a coda. Initiating correspondence among all nasals in a word results in a ranking paradox, as Tableau 8 illustrates with /qɑn-dAn/ → [qɑn-nɑn] 'blood-GEN' and /nɑn-dA/ → [nɑn-də] 'bread-LOC'. The constraint CORR-WORD[NASAL] must

/qɑn-dAn/ → [qɑn-nɑn] 'blood-GEN' /nɑn-dA/ → [nɑn-də] 'bread-LOC'	CORR-WORD [NASAL]	CC-SROLE	SYLL CON
a. qɑn̲-n̲ɑn̲ ∼ qɑn-dɑn	W	L	L
b. nɑn-də ∼ n̲ɑn̲-n̲ə	L	W	W

Tableau 8: Ranking paradox with CORR-WORD[NASAL]. Each row of the Tableau gives a winner ∼ loser pair, and the preferences of the constraints are shown.

dominate CC-SROLE and SYLLABLECONTACT for the winner in the first row to be optimal, but paradoxically, for the winner in the second row to be optimal, CORR-WORD[NASAL] must be dominated by one of the other constraints. This problem is avoided by specifying that correspondence is initiated between coda nasals specifically, and not all nasals as CORR-WORD[NASAL] demands.

Analyzing the data using Surface Correspondence Theory not only contributes to the typology of long-distance phenomena, but it also allows the model to be flexible enough to account for related patterns that do not necessarily involve nasals. In particular, Kyrgyz, a close relative of Kazakh, does not have nasal harmony, but it does have a very similar pattern involving liquids; illustrative examples are given in Table 9.

		a. /-dA/ 'LOC'	b. /-lUː/ 'ADJ'	c. /-lA/ 'VERB'	d. /-lAr/ 'PL'
/ɑlmɑ/	'apple'	[ɑɫmɑ-dɑ]	[ɑɫmɑ-ɫuː]	([ɑɫmɑ-ɫɑ])	[ɑɫmɑ-ɫɑr]
/qɑr/	'snow'	[qɑr-dɑ]	[qɑr-duː] ∼ [-ɫuː]	[qɑr-dɑ] ∼ [-ɫɑ]	**[qɑr-ɫɑr]**
/gyl/	'flower'	[gyl-dø]	[gyl-dyː]	[gyl-dø]	[gyl-dør]
/qɑn/	'blood'	[qɑn-dɑ]	[qɑn-duː]	[qɑn-dɑ]	[qɑn-dɑr]
/qɑz/	'goose'	[qɑz-dɑ]	[qɑz-duː]	[qɑz-dɑ]	[qɑz-dɑr]

Table 9: Desonorization and liquid harmony at root-suffix junctures in Kyrgyz.

As in Kazakh, suffix-initial laterals surface as [d] after laterals and segments of lower sonority. After rhotics, however, desonorization is variable, and laterals may surface faithfully (9b,c). Notably, the plural suffix /-lAr/ does not exhibit variation after rhotics. An analysis along the lines of nasal harmony in Kazakh would necessarily involve different features, but largely maintain the relative constraint rankings.

This analysis is advantageous in maintaining a connection with the phonological literature on harmony and its flexibility in applying to similar patterns. Turkic nasal harmony has commonly been analyzed using a single markedness constraint that penalizes [NDVN] strings (Eulenberg 1996, Davis 1998, Washington 2010). This is necessarily a complex constraint, for example Eulenberg's (1996) SPREADNASAL constraint specifies: "If a non-continuant onset's two neighboring codas are nasals, that onset must be nasal." Our approach organically decomposes nasal harmony into several independently motivated constraints and avoids positing brand new constraints. Analyzing Kyrgyz with a string constraint would require positing another constraint SPREADLIQUID, forfeiting a deeper connection with Kazakh, other Turkic languages, and other long-distance phenomena.

Our analysis treats Turkic nasal harmony as entirely phonological, but one could approach it as an instance of allomorphy. In particular, the suffixes that undergo nasal harmony may be associated with a distinct co-phonology (Anttila 2002) or indexed to a high-ranking constraint like AGREE(NASAL) (Pater 2010), while other suffixes are not. Such approaches are dissatisfying for two reasons. First, they involve lexically marking a class of suffixes which share the same phonological shape: all are either /-DVN/ or /-NVN/. Second, in the languages we are aware of with nasal harmony, *all* such suffixes undergo the process; there are no idiosyncratic exceptions. A lexical approach therefore misses the key phonological generalizations.

5 Conclusion

The two goals of this paper were to exemplify Turkic nasal harmony by describing in detail the facts of syllable contact and nasal harmony in Kazakh and providing an analysis of these data.

As noted in the introduction, these patterns are attested widely throughout the Turkic language family, and in future work, we intend to extend our analysis to these related patterns. Outside of Turkic, there is a similar pattern of nasalization that occurs between nasals in Bantu languages known as Meinhof's Law (Herbert 1977). This is an interesting point of comparison with Turkic nasal harmony, especially in testing how well alternative approaches generalize to related patterns.

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