

Idiosyncratically Transparent Vowels in Kazakh*

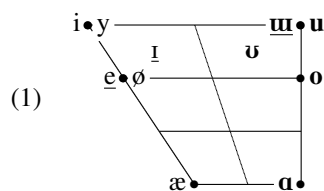
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We argue that Kazakh backness harmony presents two clear cases of affixes which are idiosyncratically transparent to harmony, a phenomenon claimed to be unattested as recently as Mahanta (2012). We base these arguments on data from fieldwork done in California with two native speakers from different regions¹ of Kazakhstan. In the following sections, we present the structure of the harmony system, summarize the theoretical status of idiosyncratic transparency, and provide analyses under two current theories of harmony: Agreement by Correspondence and Trigger Competition. We find that these theories can be amended to allow for lexical specification, and show that both can provide a fully adequate description of these data.

1 The Kazakh vowel inventory: a hypothesis

Kazakh has a robust system of backness harmony which requires native words to contain either only back² vowels or only front vowels, and suffixes alternate to match them. Harmony spreads progressively from the stem to any suffixes, and we are not aware of any prefixes that would allow us to distinguish between rightward harmony and stem-outward harmony.

Our analysis is centered on the eleven-vowel system shown below in (1). In this chart, bold type indicates backness, and an underline indicates vowels that are allowed in non-initial syllables:



Henceforth, we refer to the four vowels that are generally allowed non-initially as the alternating vowels: because of Kazakh's robust harmony system, each of these has a partner in the inventory with which it reliably alternates in derived environments. The alternating pairs, and the correspondences between our inventory and the standard Kazakh Cyrillic orthography, are shown here:

* We are indebted to Dana Kismetova and Yeskendir Kassenov for presenting their native language to us, to Vera Gribanova and Rob Podesva for their guidance on this project, and to Paul Kiparsky, Bonnie Krejci, Hanzhi Zhu, Janneke Van Hofwegen, Matt Faytak, Stephanie Shih, the audience at WAFL9, and the audience and anonymous reviewers for their valuable feedback. Usual disclaimers apply.

¹ Speaker 1 is from Atyrau in the west of the country, and speaker 2 is from Astana in the north.

² We describe a harmony system with the typologically typical [\pm BACK] contrast, though our purely acoustic observations cannot rule out a similarly structured [\pm RTR] system, as was proposed by Vajda (1994).

non-alternating front		non-alternating back	
Y [y]		Y [u]/([w]) ³	
И [i]/([j])		Ү [ʊ]	
Ө [ø]		О [o]	
Ә [æ] ⁴			
alternating front		alternating back	
І [ɪ]	~	ІІ [ɪɪ]	
Е [e]	~	А [a]	

There are two broad classes of cases in which non-alternating vowels can occur non-initially. Loanwords show the full inventory non-initially, as in (2), and the infinitive suffix appears to surface consistently as the non-alternating /uw/, as in (3). We will return to the latter case in detail below.

- (2) a. kijno ‘movie’ (Russian) b. maʃijnæ ‘car’ (Russian)
 c. askʲerij ‘military’ (Persian) d. tɔrtbɔrɪus ‘square’ (from *four-corner*)
- (3) a. qoj-uw ‘to-INF’ b. quɪr-uun-uw ‘shave-REFL-INF’

1.1 The harmony system Most suffixes in Kazakh show alternating front and back variants which harmonize with the stem, as in (4). This suffix harmony is categorical in our data: we have found no stems which can be followed by both front and back suffix variants.

- (4) a. BACK: aɣas-tar-dan *aɣas-tʲer-dʲen ‘tree-PL-ABL’
 b. FRONT: *ijt-tar ijt-tʲer ‘dog-PL’

Harmony is also categorical within native word roots. A few examples are shown in (5).

- (5) a. BACK: ʒʊmɪrtqɑ ‘egg’ sarɪmsɑq ‘garlic’
 b. FRONT: ʃʲemɪrʃʲek ‘gristle’ kyrʃʲek ‘shovel’

Loanwords may contain exceptions to harmony. In these cases, suffixes simply harmonize with the final syllable in the root, as in (6).

- (6) a. mʊɣɑlm-ɟʲe ‘teacher-DAT’ b. kɪtɑp-tar-uun-nuɪ ‘book-PL-POSS-GEN’

Systematic exceptions to vowel harmony in directional (stem-outward) harmony systems like this one fall into two classes: opacity and transparency. Opaque vowels spread harmony rightward onto other segments, but do not harmonize with the segments to their left. Transparent vowels do not regularly harmonize with vowels on either side of them, with the vowels on both sides of them instead agreeing with one another. The effect is that harmony appears to pass through transparent vowels, allowing them to remain as solitary disharmonic segments in an otherwise normally harmonizing word. While we have not found evidence of opaque vowels in Kazakh vowel harmony, some instances of transparency are clearly attested.

2 Transparency in Kazakh

We have identified three cases of transparency in Kazakh, two of which—the infinitive and comitative suffixes—follow a pattern not previously observed. The first of these three cases is the behavior of [i], which can occasionally precede back vowels. This phenomenon appears to be quite limited, though, as extremely few disharmonic /i/ tokens appeared in our sample: the examples in (7–9) comprise our full corpus of exceptional tokens of [i]. While there may be a phenomenon of grammatical interest here, the simplest explanation given such limited data is that these words are all lexical exceptions which are memorized in full.

³ Orthographic ‘Y’ seems to represent [w] in at least some cases when it follows a vowel. Whether this is an orthographic convention or a phonological reduction process from underlying /u/ is not of consequence here. И shows similar behavior.

⁴ /æ/ appears to be heavily restricted in non-loan words, and Vajda (1994) claims that it is not part of the native phonology. Our study does not attempt to address this issue, but the vowel does appear in a large number of basic vocabulary items:

- a. ækʲe ‘father’ b. æpkʲe ‘aunt’
 c. æʒʲe ‘grandmother’ d. dæn ‘seed’

- (7) sijraq ‘knee’
 (8) sij-duu ‘fit-PST’
 (9) mij-duu ‘brain-ACC’

The infinitive suffix constitutes a more robust and unusual case of transparency. This affix is realized as an offglide [w] following a vowel, but following a consonant it is realized as [uw] regardless of harmonic context:

- (10) a. V__ : qara-w ‘look-INF’ (‘to look’)
 b. V_[+bk]C__ : qoj-uw ‘quit-INF’ (‘to quit’)
 c. V_[-bk]C__ : kʲel-uw ‘enter-INF’ (‘to enter’)
 d. *mʲen jesik-ti ʒab-uw-duu yjʲen-dim*
 1SG door-ACC lock-INF-ACC learn-1SG
 I learned to lock the door.

The unprecedented transparent behavior of INF becomes apparent in (11), in which normally alternating affixes are appended to the right of the infinitive. In these cases, the affixes will look leftwards past INF to harmonize with the stem.

- (11) a. ʒyz-uw-dɪ *ʒyz-uw-duu ‘take-INF-POSS.3’
 b. kir-uw-dɪ *kir-uw-duu ‘enter-INF-ACC’

2.1 Past work and /u/ Making phonological claims about the vowel /u/ in Kazakh is not a historically uncontroversial enterprise: the existence of this vowel as a single phoneme is not universally accepted in the literature. In Vajda (1994), Tamir (2007), and Kirchner (1998), the vowel that we call /u/ (orthographic *У*) is described as a pair of different vowels which alternate according to harmonic context. These two hypothesized vowels do not have distinct targets, but instead share initial targets with other vowels, and are differentiated from them by the presence of [w] offglides: [ɔw] appears in harmonically back contexts, and [yɯ] appears in harmonically front contexts. In contrast, our speakers consciously identify both the front and back context tokens of /u/ as the same single vowel. Somfai Kara (2002) also finds that the proposed front–back difference is not present on the surface, and transcribes the vowel as a long [u:], though he assumes the same underlying forms as the other three authors.

The behavior that we observe in the infinitive is not necessarily anomalous if the vowel we call /u/ is really an alternating pair of vowels. If this is the case, it is possible that the suffix is pronounced as a front vowel in front contexts and a subtly different back vowel in back contexts. Because of this possibility, it is crucial for us to determine how the vowel we call /u/ behaves phonetically for our speakers before we proceed to propose a phonological analysis.

3 The phonetics of /u/

We are interested in two possible phonetic behaviors for /u/. For our hypothesis of a single /u/ to be clearly falsified, we would need to observe that front and back tokens of /u/ have two clearly separated distributions. Alternately, for Vajda, Tamir, and Kirchner’s competing hypothesis to be verified, we would expect these two targets to align with the targets of the existing vowels /ɔ/ and /y/ for the first phase of the vowel duration, before moving up and back towards /w/.

3.1 Methodology We presented speakers with 35 words in random order, four times each. The wordlist has the following composition:

- Nine monosyllabic words, each with a different monophthongal vowel (every vowel in (1) except /i/ and /u/). All words were of the form /t_s/ except two: /sæt/ and /suz/.
- Six minimal or near-minimal pairs containing the infinitive suffix and differing in initial vowel backness (e.g. /usuw/, /ɯsuw/). Half of the pairs were infinitives with no additional affixes, and half had the accusative suffix (/duu/ or /dɪ/) following INF. The consonant just before INF was always /s/, to match the alveolar environment of the monosyllabic words.

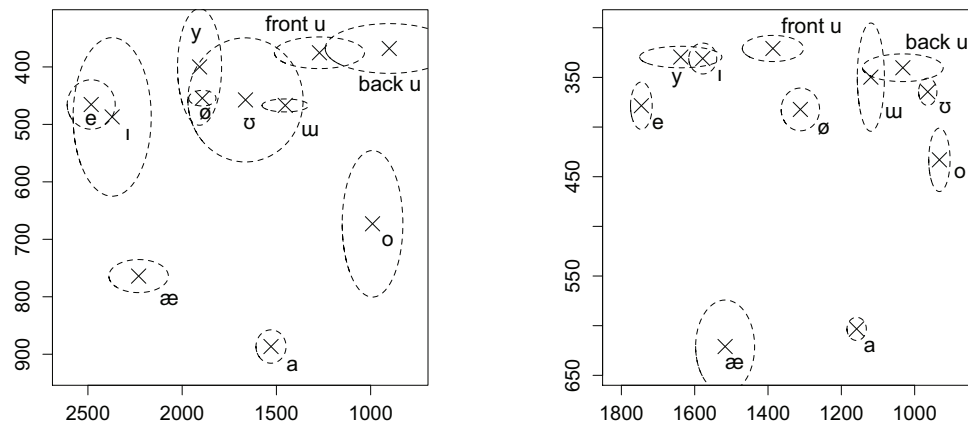


Figure 1: Vowel distributions (unnormalized formants) for speaker 1 (left) and speaker 2 (right). These plots show the mean formant measurements for /u/ at the 25% point, overlaid with the mean midpoint measurements for the other vowels. The ellipses encompass the area within one standard deviation of the mean. Speaker 1 is female, and speaker 2 is male.

- Fourteen additional words, used to investigate other issues unrelated to the status of /u/.

The speakers read the words in the simple frame sentence *m'en __ d'edim*, meaning 'I said __.' The words were presented on a computer screen one at a time in Kazakh Cyrillic orthography. Since this orthography uses only one symbol for the vowel we call /u/, it does not provide any unwanted cues. The speech was recorded a sound-proofed recording booth in the Stanford University Linguistics Lab with a 44.1 kHz sampling rate.

The recordings were subsequently analyzed using Praat (Boersma & Weenink, 2012), and a script⁵ was used to measure the first and second formants and the duration of each vowel. Formant measurements were recorded at 25%, 50%, and 75% of the way through each vowel. If INF is in fact realized as a diphthong, these positions ought to roughly correspond to its initial target, midpoint, and offglide respectively. After the measurements were completed, F1 and F2 values were converted into Bark (Z1 and Z2) values using the formula provided by Traunmüller (1997). Bark values provide a better approximation of perceptual reality than formant values, and so we use Bark units to calculate Euclidean distances between vocalic targets. Formant values were used in plotting.

3.2 Acoustic results The positions of each vowel for each speaker are plotted in figure 1. We found a difference in backness (Z2) between front and back context /u/ which was significant for both speakers and large for speaker 2. This suggests a potential split of our /u/ into two vowels. However, we also observed significant ($p < 0.01$) differences between the 25% targets of front-context /u/ and [y] and between back-context /u/ and [ø], suggesting that the standard hypothesis from earlier literature does not hold for our speakers. While these results do not unambiguously suggest one phonological interpretation, we adopt the working assumption that /u/ is a single phoneme, and that the differences observed between its front and back realizations are due only to coarticulation.

Table 1 shows the average slope between the Bark coordinates at the 25% and 75% points for [u] and [y], as well as the standard deviation in slope, and the average Euclidean distance between them. Both speakers' pronunciations of /u/ had just a small amount of formant dynamism (interpreted as the distance between the 25% and 75% formant values), and direction of movement was quite variable. In contrast, the true diphthong [yj] in [syjdi] 'love-PST' showed consistent movement across a much greater distance. This evidence does

⁵ We used a modified version of Katherine Crosswhite's FORMANT-LOGGER script: http://www.linguistics.ucla.edu/faciliti/facilities/acoustic/formant_logging.txt

	Slope	Slope std. dev.	Distance
Front-context /u/, speaker 1	-0.0263	3.9652	0.3819
Back-context /u/, speaker 1	-0.2294	7.1418	0.4871
/yj/, speaker 1	0.4130	0.6702	1.1447
Front-context /u/, speaker 2	0.9003	2.2534	0.3091
Back-context /u/, speaker 2	-0.2451	1.1775	0.4902
/yj/, speaker 2	-2.8256	0.2416	2.9975

Table 1: The mean and standard deviation of the slope between the 25% and 75% points of /u/ by context and by speaker and the associated distance, with the true diphthong /yj/ included as a control.

not support the claim that INF is a surface diphthong, at least for our speakers.

We also found substantial variation between our two speakers in the duration of [u], but in general [u] is slightly longer than the other high round monophthong [y] ($p < 0.05$ for both speakers) but much shorter than the diphthong [yj] ($p < 0.005$ for both speakers).

4 The comitative suffix

With the phonetic results compatible with the analysis of INF as idiosyncratically transparent, but somewhat inconclusive, it is worthwhile to look elsewhere in the phonology for other possible cases of idiosyncrasy that might shed light on this pattern. The comitative suffix fills just this role. The harmonic behavior of the comitative has not been documented to our knowledge, and it shows a variant of the same anomalous behaviour seen with INF. The suffix is realized as /mⁱen/ (/pⁱen/ in some consonantal environments) and is also non-alternating:

- (12) a. BACK: ɑdam-mⁱen *ɑdam-man/-mun ‘person-COM’
 b. FRONT: ystyl-mⁱen *ystyl-man/-mun ‘table-COM’

We have only found one affix that can follow COM, a harmonically alternating question particle, but this affix shows that COM too is transparent:

- (13) *bʊl fal nan-mⁱen-ba*
 this old.man bread-COM-Q
 Is this an old man with some bread?
- (14) *bʊl fal bøbⁱek-pⁱen-bⁱe*
 this old.man baby-COM-Q
 Is this an old man with a baby?

Demonstrating the transparency of COM is also less troublesome than for INF,⁶ since there are other suffixes containing the same vowel that participate in harmony normally, for example PTCP here:

- (15) *tɪstⁱe-gⁱen-ɪ* ‘bite-PTCP-POSS.3’
 (16) *ɑdar-ɣan-ɪ* ‘turn.over-PTCP-POSS.3’

⁶ An audience member at Phonology 2013 proposed that the behavior of the front–back alternation in question particle might be analyzed as a case of morphological subcategorization rather than harmony, and that COM was not necessarily exceptional. This analysis, while possible, violates Poser’s (1985) empirically well supported (Paster, 2006) Determinant Focus Adjacency Condition, which holds that morphological subcategorization can only be sensitive phonological properties of a small amount of material at the *nearest edge* of the stem of affixation, generally taken to include at most the rhyme in cases of suffixation. Since the rhyme of the right edge of the stem of affixation for the question particle in (13–14) contains only the non-alternating COM, it is not possible to explain the alternation as resulting from subcategorization without violating this condition.

This affix serves as a second corroborating case of idiosyncratic transparency, motivating our interpretation of /u/ as a single vowel, and inviting an analysis of idiosyncratic transparency as a genuine possibility within phonological grammar.

5 A constraint-based account

5.1 *The status of idiosyncratic transparency* Transparent vowels are extremely well documented in the harmony literature, and show up in a variety of language families. Morphological exceptions to harmony are also not new, and idiosyncratic opaque affixes have been seen in a number of languages, including (e.g. Baković, 2000). As recently as Mahanta (2012), though, true idiosyncratic transparency was claimed to be unattested. A potential case of idiosyncratic transparent affixes have been documented only in Karimojong (Lesley-Neuman, 2007), but have been explained as a problem of morpheme ordering rather than of harmony, an option not viable for Kazakh.

5.2 *The basics of a generative account* We have found what we claim to be a novel phonological phenomenon, and in the following sections, we propose a constraint based analysis of this phenomenon. Before we make any novel proposals about vowel harmony, however, it is necessary to lay the groundwork of constraints to handle the rest of the structure that we have found in vowel inventory.

First among these is a constraint to restrict the occurrence of the non-alternating vowels. We use a context-free markedness constraint to penalize their occurrence, which could be factored into a set of feature bundle markedness constraints, but which we present as a single large constraint in (17) for brevity. This is counterbalanced by two positional faithfulness constraints, one (18) protects the initial syllable to allow marked vowels to occur there, and the other (19) specifically protects the infinitive suffix (in the style of Pater, 2009) to allow [u] to surface there:

(17) *{iuyuoøæ}

(18) IO-IDENT-INITSYLLABLE

(19) IO-IDENT-INDEXED[INF]

Here, we demonstrate that this provides the correct distribution of vowels for the already-harmonic input $k\theta^j er-uw$ ‘raise-INF’⁷:

/kθ ^j ær-uw/	INITID	INDXID	*{iuyuoøæ}
a. [k ^j et ^j ær-yw]	2 W	2 W	1
b. [k ^j et ^j er-yw]	1 W	1 W	L
c. [k ^j et ^j ær-uw]	1 W		2 W
d. [k ^j et ^j er-uw]	1 W		1
e. [kθ ^j ær-yw]		1 W	2 W
f. [kθ ^j er-yw]		1 W	1
g. [kθ ^j er-uw]			1

5.3 *Approaches to harmony* With this groundwork established, it is necessary to choose a harmony constraint. How to account for harmony in constraint-based grammar remains an open question, and no current proposal explicitly allows for idiosyncratic transparency. As such, we are motivated to choose a system whose representations are sufficiently flexible that it can be straightforwardly modified to account for this phenomenon.

We begin by cutting the past proposals into two broad classes. Strictly local (after Gafos, 1999; Ní Chiosáin & Padgett, 2001) accounts, most prominently those based on AGREE and ALIGN, assume that

⁷ We follow the standard practice of ‘perversely’ assuming an underlying form that is substantially different from the intended output, but that we would expect to yield that output.

harmony is between neighboring segments at some level of representation. In contrast, non-local accounts explicitly allow harmony to pass between non-adjacent segments.

Strictly local accounts make much more focused typological predictions, but they are handicapped in accounting for transparency. Since transparency superficially involves the identity of the harmony feature being shared non-locally between segments on both sides the transparent vowel, strictly local systems require supplemental mechanisms, often of considerable complexity, to account for it at all. Further, there are known cases of transparency which cannot be accounted for by any standard mechanism (Bowman, 2013). In particular, if the harmony constraint is local, the only way to prevent a vowel from propagating harmony is to either prevent it from appearing at the appropriate level of representation using an indexed constraint or diacritic or to neutralize it postlexically using a similar method (seen, for example, in Ringen & Vago, 1998 and Baković & Wilson, 2000 for regular transparency). The flexibility that either approach demands of the representational scheme essentially creates a new and potentially unwieldy non-local system.

Because of this, we focus on the two non-local theories of harmony that appear to be under most active development at this time, Agreement by Correspondence (ABC, Rose & Walker, 2004; Rhodes, 2012) and Trigger Competition (TC, Kimper, 2011), and present analyses in both.

5.4 Agreement by Correspondence ABC was developed for consonant harmony in Rose & Walker (2004). It is centered on a two-part analysis of agreement: one mechanism establishes correspondences between similar segments—analogueous to the correspondences between input and output segments—and another enforces identity between them. This is implemented with two families of OT constraints:

- (20) **CORR-VV** – Let S be an output string of segments and let X and Y be segments specified [-CONS, +SON]. X and Y correspond if $X, Y \in S$.
- (21) **IDENT-VV(BK)** – Let X be a segment in the output and let Y be a correspondent of X in the output. If X is [α BACK], then Y is [α BACK].

This is demonstrated for a very simple case here. If two segments share a subscript (e.g. ‘ x ’), they are in correspondence:

/ijt-tar/	INITID	*{iuyuoøæ}	CORRVV	IDENTVV[BK]
a. [i _x jt-ta _y r]			1 W	
b. [i _x jt-ta _x r]				1 W
c. [i _x jt-tæ _x r]		1 W		
d. [i _x jt-t ^l e _x r]				
e. [tu _x t-ta _x r]	1 W			

We base our account on Rhodes’s (2012) expansion of ABC to account for vowel harmony with transparency. This expansion centers on what he calls weak and strong specification. Features can be either weakly or strongly specified for either value of the harmonic feature, and while both weak and strong specifications produce the same acoustic effect, phonological processes can restrict their domains to only strongly specified segments. Rhodes proposed that weak and strong specification is distributed as follows:

If vowels contrast with each other based only on carrying the opposite [BACK] values, both vowels are strongly specified (e.g., /a/ and /ä/ differ only in backness, so they are strongly specified for the feature). If, however, a vowel does not contrast with any other vowel based only on carrying opposing [back] values, that vowel is weakly specified. (Rhodes, 2012)

Rhodes uses this to enforce correspondence only between strong vowels using a variant correspondence constraint, CORR_{V_S}V_S, thereby preventing the weak vowels from participating in harmony. We take advantage of this proposal solely for its structural function. The generalization that transparency (and here, weakness) can be inferred from the structure of the inventory is not strictly true cross-linguistically (Kimper, 2011; Bowman, 2013). However, allowing a property of the vowel specification to determine the distribution of transparency allows us to introduce exceptions into that distribution. We adopt the assumption that the distribution of weak specification must be a synchronically real part of the grammar that is learned for each

language, and newly claim that it can be learned to be idiosyncratic for individual tokens of vowels in specific morphemes in situations when a learner has overwhelming evidence of exceptional behavior.

With this established, the derivation of a transparent case like *kır-uw-dı* is relatively straightforward. We take all vowels in the language to be strongly specified for backness, except for /u/ in INF (marked as weak with a \dagger in the input). The new correspondence constraint ensures that INF is then exempted from harmony:

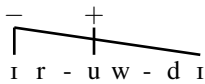
/kır-u [†] w-dıu/	INITID	INDXID	*{iuyooøæ}	CORRV _S V _S	IDENTVV[BK]
a. [k _x r-u _y w-dıu _y]			1	1 W	
b. [k _x r-u _y w-dıu _x]			1		1 W
c. [k _x r-u _y w-dı _x]			1		
d. [k _x r-u _x w-dı _x]			1		2 W
e. [k _x r-ı _x w-dı _x]		1 W	L		
f. [k _x r-ı _y w-dı _x]		1 W	L		
g. [ku _x r-u _y w-dıu _x]	1 W		1		

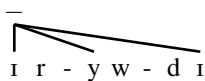
The case of COM is analyzed similarly, though here there is no need for an indexed faithfulness constraint, since COM has no marked vowels that need special protection from the faithfulness constraint:

/nan-m [†] e [†] n-b [†] e/	INITID	*{iuyooøæ}	CORRV _S V _S	IDENTVV[BK]
a. [na _x n-m [†] e _y n-b [†] e _y]			1 W	
b. [na _x n-m [†] e _y n-b [†] e _x]				1 W
c. [na _x n-m [†] e _y n-ba _x]				
d. [na _x n-m [†] e _x n-ba _x]				2 W
e. [n [†] e _x n-m [†] e _y n-b [†] e _x]	1 W			

This leaves us with a working account of the harmony data presented above.

5.5 Trigger Competition Trigger Competition (Kimper, 2011; Bowman, 2013) shares many similarities in its conceptual framing with ABC, but it is implemented in a very different grammatical framework, and makes one crucial additional assumption about how participation in harmony is conditioned. TC is set in a weighted grammar, and allows multiple learned numeric parameters to contribute to harmony behavior. Transparency can be introduced, in part, through these parameters. The representations in TC are autosegmental, though transparency is represented with crossing lines, as in (22) here, and in contravention of conventional restrictions on line crossing in standard autosegmental theories.

(22) 

(23) 

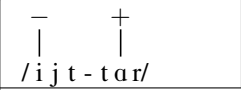
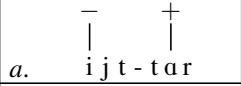
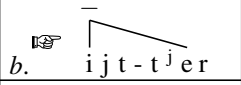
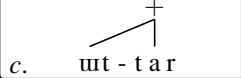
Further, TC is set in Serial Harmonic Grammar (SHG, Pater et al., 2008; Pater, 2010; Mullin, 2010). In an SHG grammar, derivations are stepwise. The grammar is allowed to make only one step in each tableau, but builds outputs by evaluating multiple times, taking the output of each step as the input to the next, until no further changes are optimal. While positive constraints—those that reward certain structures rather than penalizing them—cause problems in fully parallel grammars, they are well behaved and commonly used serial grammars like SHG. Harmony is enforced by the positive constraint SPREAD, which compels segments to spread their feature values onto other segments by forming autosegmental links:

(24) **SPREAD[F]**: Assigns a reward for each additional segment linked to a value of feature F.

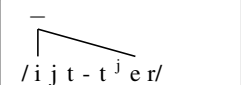


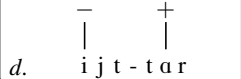
The precise magnitude of the reward assigned for a given instance of spreading depends on the quality of the vowel that is spreading its feature value. In this formulation, each vowel type in the language has an

associated numeric trigger strength, and that strength serves as the reward for spreading from a given trigger. As in Rhodes's expansion of ABC, there is a theory which proposes to heavily constrain the distribution of trigger strengths, and thus the distribution of transparency, on the basis of the vowel inventory, but also as above, we ignore this theory in favor of a lexical specification approach. As a starting point, we set the trigger strength to 5 for all normally alternating vowels.⁸

This is demonstrated in a simple case, without transparency, below. In the first step, the faithful candidate (*a*) violates no constraints, but the highest score can be achieved by spreading harmony as in *b*, so that output is chosen:

	INITID -20	INDXID -20	*{iuyooøæ} -10	SPR[±BK] +1	\mathcal{H}
<i>a.</i> 	0	0	0	0	0
<i>b.</i> 	0	0	0	5	5
<i>c.</i> 	1	0	0	5	-15

After this, no other change is optimal⁹ and the derivation converges:

	INITID -20	INDXID -20	*{iuyooøæ} -10	SPR[±BK] +1	\mathcal{H}
<i>a.</i> 	0	0	0	5	5
<i>b.</i> 	0	0	0	0	0
<i>c.</i> 	0	0	0	5	5
<i>d.</i> 	0	0	0	0	0

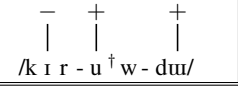



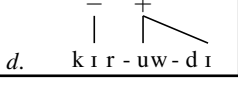
In TC, transparent vowels can emerge only in the presence of a conspiracy between two mechanisms: segments that are prevented from alternating by some other constraint are neutral, and neutral segments with low trigger strengths will not interact with harmony, and are thus transparent. Notably, a weak trigger strength alone is not adequate, since weak triggers are not inherently prevented from undergoing harmony.

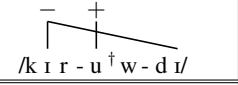



An indexed constraint—of the sort that we have already proposed for INF—can be expanded to protect both INF and COM from alternating, and can thereby ensure that they behave as neutral. To make them transparent it is necessary to posit that transparency can be learned as a property of individual morphemes, much as we did for weak specification in ABC. Here, this takes the form of proposing that the trigger strength for /u/ in INF and /e/ in COM is idiosyncratically weaker than for other tokens of those vowels.

⁸ This presentation is somewhat simplified from Kimper's work. Most notably, the full implementation has a mechanism for accounting for distance-sensitivity effects of the sort seen in Hungarian. In this mechanism, a learned distance sensitivity parameter (here 1, but potentially a fraction) is multiplied by the assigned score once to reduce it for every segment skipped over by spreading.

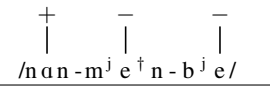
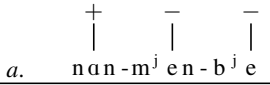
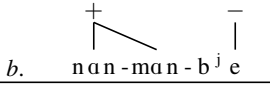
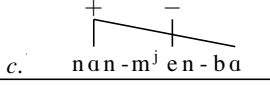
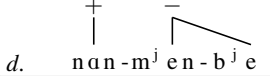
⁹ I include candidate *c* to show that the positive spread constraint doesn't actively encourage the epenthesis of harmonic vowels. We assume that some constraint against epenthesis (not shown) would prevent this candidate from even tying with the normal harmony candidate, *a*.

We demonstrate transparency in our interpretation of TC below¹⁰ In the following examples, we set *all* vowels in Kazakh to have a default trigger strength of 5, and allow INF and COM to have vowels of strength 1:

	INITID[±BK] -20	IDXID -20	*{iuyooøæ} -10	SPR[±BK] +1	\mathcal{H}
a. 	0	0	1	0	-10
b. 	0	1	0	5	-15
c. 	0	0	1	5	-5
d. 	0	0	1	1	-9

	INITID[±BK] -20	IDXID -20	*{iuyooøæ} -10	SPR[±BK] +1	\mathcal{H}
a. 	0	1	0	5 + 5 = 10	-10
b. 	0	0	1	5	-5
c. 	0	0	1	1	-9

The comitative works in entirely the same way. The first tableau of its derivation is shown here:

	INITID[±BK] -20	IDXID -20	*{iuyooøæ} -10	SPR[±BK] +1	\mathcal{H}
a. 	0	0	0	0	0
b. 	0	1	0	5	-15
c. 	0	0	0	5	5
d. 	0	0	0	1	1

The above suffices to provide a sufficient account for the novel Kazakh data that we describe. It should be noted, though, that the indexed identity constraint is crucial to prevent INF from undergoing harmony, not

¹⁰ From this point on, all examples will contain only left-to-right spreading, and not the reverse. This follows the descriptions of directional harmony languages in Kimper, and can be formally implemented as described in Bowman (2013).

just for preventing it from neutralizing: unlike in ABC, we cannot leave it out in accounting for COM. This requirement is the only substantial difference between our proposals under the two systems, and may work in TCs favor by providing a potential basis for an explanation of the rarity of idiosyncratic transparency. There are many unresolved issues in the study of harmony, though, that may bear on the choice of constraints and representations, including the relationship between consonant harmony and vowel harmony, the relationship between inventory structure and participation in harmony, and the articulatory reflexes of transparency. We do not mean to explicitly advocate for either of the two theories on the basis of data which both can capture.

6 Conclusion

We find that Kazakh shows two suffixes which are idiosyncratically transparent to vowel harmony. One of these suffixes contains the vowel /u/, which appears to correspond to a single surface vowel in Kazakh for our speakers. However, even setting aside the somewhat unclear status of this vowel in language, the behavior of the comitative suffix serves to demonstrate the possibility of idiosyncratic transparency. Both ABC and TC can be modified to admit analyses of this novel phenomenon. Though they differ primarily in their architectural assumptions, their treatments of the phenomena also differ slightly, with TC requiring two separate lexical specifications in all cases.

These observations also invite further research into the typology of idiosyncratic transparency. With no established typology of these exceptions, it is difficult to determine just how difficult and unusual it is for them to emerge or persist in a language. A study of lexical exceptionality consonant harmony could be valuable as well. Research is also ongoing into the relation between vowel harmony and long distance consonant agreement and dissimilation patterns, and it could be theoretically productive to search for cases of exceptionally transparent consonants to determine if this type of exception is unique to vowel systems, or a feature of agreement systems more broadly.

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