A Survey of Vowel Harmony with Special Focus on Neutral Segments, Glides, and Diphthongs

Prospectus for the Ph.D. in Linguistics
University of California, Berkeley

Russell Rhodes
2010-04-01

1 Introduction

The current paper presents the results of a preliminary survey of vowel harmony systems. The purpose of this survey is to gain a better understanding of transparency in vowel harmony; both vowel transparency and glide transparency. In §2, I lay out how I selected the languages for inclusion in the current survey of harmony systems. Additionally, I outline what information I collected about each language and harmony system in the survey. In §3, I give the reader a peak at the contents of the survey. Specifically, I present detailed data from the height and tongue root harmonies surveyed. Here I discuss the range of data found related to neutral segments, both transparent and opaque, and related to glides and diphthongs. In §4, I present the main findings for the survey. This discussion draws both on data presented in §3 and other unpresented data. Finally, §5 offers a brief conclusion.

2 Methodology

In deciding what counted as harmony for the current survey, I took the following broad definition from Archangeli & Pulleyblank (2007) as my starting point: “a harmony system requires that two or more non-necessarily-adjacent segments must be similar in some way.” I did not, for example, exclude anything just because it applied to only a few (or even as few as just one) affixes. Nor did I exclude non-iterative vowel agreement. In effect, this meant that if a previous researcher labeled something as harmony, I was willing to include it. However, given the fact that this survey is meant to address issues of vowel transparency, which is only apparent when harmony can apply to multiple vowels, I did try to include a relatively large number of languages in which agreement has iterative and (nearly) exceptionless application. For all types of harmony other than tongue root harmony, this led to at least some skew towards particular language families. This is a weak point with the survey that I hope to rectify as I expand it.

In terms of actually selecting the languages, almost half (24) were found in previous surveys (Aoki 1968; van der Hulst & van de Weijer 1995; Archangeli & Pulleyblank 2007) or dissertations (Kaun 1995; Mahanta 2007) or were languages that I was already familiar with (Akan, Assamese, Bashkir, Buriat, Chichewa, Chamorro, Chukchi, Djingili, Degema, Efik, Finnish, Hungarian, Igbo, Karachay, Kera, Khalkha, Menominee, Nawuri, Oroch, Somali, Turkish, Tuvan, Wolof, Yakut).
In an effort to include at least some languages that had not been discussed so much in previous surveys, I took 19 languages from Jeff Mielke’s database of phonological processes, P-data\(^1\), (Armenian, Azari, Ciyaol, Dàgáárà, Desano, Dhaasanac, Efik, Ekegusii, Evenki, Ijó, Ikalinga, Ingessana, Kimatuumbi, Kinyarwanda, Koromfe, Kukú, Lango, Tangale, Warlpiri).

Finally, I included 8 languages that were either brought to my attention in person or were found in looking through grammars (Arapaho, Buchan Scots English, Kham, Ogbronuagum, Oroqen, Pendau, Pasiego Montañes Spanish, Copainalá Zoque).

All of this yielded a survey including 51 languages from 13 language families\(^2\). Quite a few of these languages have multiple harmony systems (e.g. Khalkha has both labial and tongue root harmony). As a result the number of systems included in the survey is quite a bit higher than the number of languages. The survey includes 77 harmony systems.

For each language I noted family (and also often genus), location, and its ISO 639-3 code\(^3\). Additionally, I noted the source(s) that I used, the monophthong inventory, the diphthong inventory, whether the diphthongs were derived or underlying, the glide inventory, whether the glide behaves like a vowel or a consonant, stress, syllable structure, and some basic morphological information (such as whether the language is suffixing or has reduplication).

For each system I then noted the type of harmony: height, palatal, labial, tongue root\(^4\), or other. I classified languages as other if the nature of the harmony did not obviously fit into one of the other four categories. Warlpiri is an example of a language with a system that I classified as other. Warlpiri has a three vowel system and includes a harmony that backs and rounds [i] before [u] in certain suffixes. Given that [i] and [u] differ in both backness and rounding, it is not clear whether this should be classified as palatal harmony, labial harmony, or something else. Whenever I classified a system as other I would make some note about the effect of harmony (e.g., backing and rounding for Warlpiri).

For each system I also noted any dependent feature (i.e. any feature that harmony was parasitic on), transparent vowels, opaque vowels, the behavior of diphthongs in the system, the behavior of glides in the system, the domain of harmony, and the directionality. For the behavior of glides, I took an author’s failure to mention anything as the first piece of evidence that glides were transparent in that language. I did this because it is so notable when they do participate that I would expect an author to highlight it if they did. I then went through as much data as possible looking for confirmation that indeed glides were transparent. Although I did not always find the crucial data that showed the non-participation of glides, I never came across data that indicated that glides participated when it was not explicitly mentioned by the author.

Finally, I wrote a short description of each harmony system including the basic facts, along with anything particularly noteworthy that was not fully captured in the fields above.

### 3 Survey Overview

In the current section, I will go over in some detail the contents of a portion of the current survey. In particular, I will focus here on height and tongue root harmonies. This should give the reader

---

\(^1\)Available at <http://aixl.uottawa.ca/~jmielke/pbase/>.

\(^2\)Appendix A contains a list of all the languages in the survey, along with language family and location information.

\(^3\)The World Atlas of Language Structures Online (http://wals.info/index) was an invaluable resource, both for efficiently collecting this information and for finding sources for many of the languages in the survey.

\(^4\)For the purposes of this paper, I use Tongue Root Harmony as the cover term for harmonies that have been described as [ATR], [RTR], [tense], and [constricted pharynx] harmonies.
some idea of the range of data collected on each type of harmony system.

### 3.1 Height Harmony

Among the languages surveyed, 12 exhibit some form of height harmony: Buchan Scots English (Fitzgerald 2002; Paster 2004), Chichewa (Harris 1994; Mtenje 1985), Copainalá Zoque (Harrison et al. 1981), Ciyao (Ngunga 2000), Desano (Kaye 1970), Ekegusii (Cammenga 2002), Ikalanga (Letsholo 2007), Kera (Pearce 2003), Kinyarwanda (Kimenyi 1979), Kham (Watters 2002), Kihmatuumbi (Odden 1996), and Pasiego Montañes Spanish (McCarthy 1984). Half of these are Bantu languages. This is because, as Hyman (1998) points out, although height harmony is relatively rare cross-linguistically, it is well-attested in Bantu languages. Therefore, given the goal of having each type of harmony approximately equally well represented in the survey, this imbalance is understandable. Still, it is important to be aware of the imbalance when drawing conclusions about height harmony systems based on the current collection of languages.

#### 3.1.1 Neutral Vowels

In the height harmonies surveyed, all of the logical possibilities with respect to neutral vowels are attested. There are languages with at least one opaque vowel\(^7\) (all of the Bantu languages). There is one language with transparent vowels (Pasiego Montañes Spanish). And there are languages with no neutral vowels (Desano, Kera, Copainalá Zoque).

In the Bantu languages included in the survey, the low vowel [a] is opaque. Chichewa, which is spoken in Mozambique, Malawi, Zambia, and Zimbabwe, illustrates this especially clearly. The vowel inventory and relevant data\(^8\) are given in (1) and (2), respectively.

(1) Chichewa vowels
   High: i u
   Mid: e o
   Low: a

(2) a. Causative suffix (-its/-ets)
   put-its-a ‘provoke’ (caus.)
   konz-ets-a ‘correct’ (caus.)
   bal-its-a ‘give birth’ (caus.)

b. Reciprocals suffix (-an)
   put-an-a ‘escort’ (recip.)
   konz-an-a ‘correct’ (recip.)

c. Causative suffix following Reciprocal suffix
   put-an-its-a ‘provoke’ (recip. caus.)
   konz-an-its-a ‘correct’ (recip. caus.)

\(^5\)I follow Harris in treating Chichewa harmony as height harmony, rather than as tongue root harmony, as Mtenje does.

\(^6\)I count Ikalanga’s system as height harmony because it is strikingly similar to Chichewa’s.

\(^7\)For some of these languages it would be more appropriate to say that they seem to have opaque vowels. I will return to this issue shortly.

\(^8\)Chichewa data taken from Harris (1994) and Mtenje (1985).
In Chichewa, harmony restricts the distribution of non-low vowels in suffixes. Mid suffix vowels ([e], [o]) only follow mid vowels and high suffix vowels ([i], [u]) only follow high and low vowels, as shown in (2a). In contrast, the distribution of suffix [a] is not restricted, as shown in (2b). For this reason, it is said to be neutral. Additionally, if [a] comes between two non-low vowels, the height of the second non-low vowel is always high, even if the preceding non-high vowel is mid, as shown in (2c). In other words, harmony does not apply across [a], so it is opaque. Among the other Bantu languages exhibiting height harmony in the survey, all of them, except for Ekegusii, show patterns similar to this: non-low vowels harmonize and [a] is neutral. In my sources for languages other than Chichewa, it is not as clearly established that [a] blocks harmony (forms like those in (2c) are absent). In spite of this, I take the descriptions to indicate that [a] is indeed opaque. All authors indicate that alternating suffixes are high following [a] and make no mention of exceptions to this pattern. If [a] were transparent, there would be exceptions to report.

Ekegusii, a language of Kenya, differs from the other Bantu languages in the survey in that, in addition to [a], high vowels block height harmony. The vowel inventory and relevant data are given in (3) and (4), respectively.

(3) Ekegusii vowels
- High: i u
- Higher Mid: e o
- Lower Mid: ε ɔ
- Low: a

(4) a. o-yeenr-e ‘let us go’
   o-mo-te ‘tree’
   b. o-reent-i-e ‘he has brought’
   e-űom-ɔ ‘marriage’
   ti-to-o-ko-ŋa-βa-teeb-i-a ‘we will not be telling them’

As we can see in (3) there are two mid vowel heights: higher and lower mid. Affix mid vowels agree in height with root mid vowels, as shown in (4a) (roots are in bold). If a non-mid vowel intervenes between an affix mid vowel and the nearest root mid vowel, agreement is blocked, as shown in (4b). For example, notice that the first vowel in ‘marriage’ is higher mid, rather than lower mid, which would match the mid vowel in the root. The height of the first vowel can be attributed to the presence of [u] between the two mid vowels.

While the fact that Ekegusii has four distinct vowel heights makes it possible for high vowels to be neutral with respect to height harmony, having that many height distinctions does not guarantee that the high vowels will be transparent or opaque. Kimatuumbi, which is spoken in Tanzania, also distinguishes four vowel heights, but still, as in Chichewa, all of the non-low heights are subject to harmony. The vowel inventory and relevant data are given in (5) and (6), respectively.

(5) Kimatuumbi vowels

---

9 Harmony is also generally observed root-internally.

10 Data taken from Cammenga (2002).

11 Data taken from Odden (1996).
(6) Passive suffix (-ilw/-ilw/-elw)
    kún-ilw-a ‘be grated’
    úug-ilw-a ‘be bathed’
    bóol-elw-a ‘be de-barked’

As we can see in (6), because vowel harmony in Kimatuumbi restricts the distribution of all non-
low vowels, there are three allomorphs of suffixes like the passive, not just two as in languages like
Chichewa.\footnote{In addition to the difference in number of vowel heights, Kimatuumbi differs from Chichewa in that the former shows what Hyman (1998) calls the ‘asymmetric’ pattern of height harmony, while the latter shows the ‘symmetric’ pattern. In the asymmetric pattern, the details of harmony differ depending on whether the potential harmony target is front or back. In the symmetric pattern, harmony applies identically to front and back vowels. See Hyman’s introduction for a more detailed explanation. Among the Bantu languages surveyed, only Chichewa and Ikalanga show the symmetric pattern.}

Although [a] is opaque in all of the Bantu languages surveyed, low vowels can also be transparent
to height harmony, as they are in Pasiego Montañes Spanish.\footnote{Pasiego also displays ATR harmony, which I will not be discussing in this section.} The Pasiego vowel inventory is given in (7) and the relevant data are in (8)\footnote{Pasiego data taken from McCarthy (1984). Transcription and presentation of inventory based on Vago (1988).}.

(7) Pasiego Montañes Spanish vowels

<table>
<thead>
<tr>
<th>+ATR</th>
<th>-ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>High:</td>
<td>i</td>
</tr>
<tr>
<td>Mid:</td>
<td>e</td>
</tr>
<tr>
<td>Low:</td>
<td>a</td>
</tr>
</tbody>
</table>

(8) a. lubúkus ‘young wolves’
    destorðér ‘to wring’
    b. legatérna ‘lizard’
    skálámbróxo ‘dog-rose’

In Pasiego, all non-low vowels in a word agree in height with the vowel in the stressed position, as
shown in (8a). In (8b) we see that this is true even if a low vowel appears between non-low vowels.
Since low vowels can appear in words with both high and mid vowels and their presence does not
affect agreement between non-low vowels, the low vowels are transparent.

In addition to height harmonies including transparent or opaque vowels, the current survey
includes three languages with systems that lack neutral segments completely: Desano, a Tucanoan
language, Kera, an Afro-Asiatic language, and Copainalá Zoque, a Mixe-Zoque language. Unlike all
of the languages discussed so far, in which low vowels lack any higher counterpart, these languages
have perfectly symmetrical vowel inventories, as shown in (9).

(9) a. Desano
    High vowels: i u u
    Non-high vowels: e a o
b. Kera
   High vowels: i i u
   Non-high vowels: e a o

c. Copainalá Zoque
   High vowels: i ñ u
   Non-high vowels: e a o

3.1.2 Diphthongs and Glides

The height harmonies surveyed do not tell us much about the behavior of diphthongs in vowel harmony because most of the the languages are not reported to have diphthongs and in those languages that do have diphthongs, like Scots Buchan English, I did not come across data revealing how those diphthongs behave with respect to vowel harmony. By contrast, the height harmony systems in the current survey do help us begin to get a picture of glide behavior.

For the most part, glides appear to simply be transparent, even when the corresponding high vowels participate in harmony. For example, in Chichewa, Ciyao, and Kimatuumbi, while (super) high vowels harmonize, glides are simply irrelevant to harmony, as we can see in (10).

(10) a. Chichewa Causative (-its/-ets) (Mtenje 1985:39)
   pelekez-edw-ets-a ‘escort’ (pass. caus.)

b. Ciyao Intensive Extension (-is-j/-es-j-) (Ngunga 2000:172)
   -gej-es-j-a ‘belch a lot’

c. Kimatuumbi Passive (-ilw/-ilw/-elw) (Odden 1996:101)
   chól-eje-lwa ‘be made to draw’
   pímikijilwa ‘be sold to’

Here we see that in these three languages an alternating suffix agrees with the height of the preceding vowel even when a glide intervenes (trigger, target, and intervening glide in bold).

Unlike in Chichewa, Ciyao, and Kimatuumbi, glides trigger height harmony in Pasiego, as shown in (11).

(11) mólér ‘to grind’ muljënda ‘grinding’
    bebér ‘to drink’ bóbjëndu ‘drinking’

Recall that in Pasiego non-low vowels agree in height with a non-low vowel in the stressed syllable. As a result, when the stressed syllable contains a mid vowel, the remaining non-low vowels are expected to be mid as well. This is what we find in the basic forms on the left in (11), where the unstressed vowel (in bold) is mid. The derived forms on the right, however, are exceptional. Although the stressed vowel is mid, the unstressed vowel (again bolded), is high. The crucial difference between the stressed vowels in the basic and derived forms is that the stressed vowel in the derived form is preceded by a glide, which is necessarily high.

There are a number of important things to keep in mind when considering height harmony triggered by glides in Pasiego. First, according to Kaisse & Levi (2004) and Levi (2004), glides in Spanish are all derived from vowels, so their behaving like vowels is perhaps less surprising. Additionally, although glides trigger harmony when they appear following a consonant, Kaisse & Levi report that they are transparent in other positions\footnote{Data taken from Kaisse & Levi (2004)}, as shown in (12).
(12)  a. Krejér *krijér ‘to believe’
    b. koxájs *kuxájs ‘take 2p pl subj’

(12a) shows that an intervocalic glide directly preceding the stressed vowel does not trigger harmony and (12b) shows that a glide following the stressed vowel also does not trigger height agreement. Kaisse & Levi account for the variable behavior of glides by appealing to syllable structure: post-consonantal glides are in the nucleus, while glides in other positions are non-nuclear. This is a good idea to keep in mind as we look at the behavior of glides in other languages in the survey. As we will see, glides are consistently irrelevant to harmony when they appear in positions that are clearly non-nuclear.

Finally, it is important to be aware that in spite of obvious similarities, there might be differences between agreement triggered by high vowels and agreement triggered by glides. While low vowels are clearly transparent when harmony is triggered by a full vowel (see (8b) above), it is not as clear that they are transparent when glides serve as the trigger. McCarthy reports that, in words with glide-triggered height harmony, he has ‘found no unimpeachable examples of vowel raising across an intervening neutral a’ (302).

In contrast to Pasiego, which has glides that trigger height agreement, Ekegusii has a glide that blocks harmony. As we can see in (13), the back glide, [w], is opaque.

(13) e-nwɔɔm-o ‘marriage’

As shown above in (4), in Ekegusii, mid vowels in affixes are normally the same height as mid vowels in the root. Based on this pattern, we would expect the first vowel in the word in (13) to be lower mid like the vowels in the root (the bolded portion). This is not what we find though. The first vowel is higher mid because [w] intervenes between the potential target vowel and the trigger vowel(s) in the root.

The behavior of [w] is perhaps unsurprising given that, according to Cammenga (2002), [w] is always derived from a vowel in Ekegusii and high vowels block harmony, as seen above in (4b). Interestingly, when [w] is derived from a mid vowel some speakers are willing to accept a pronunciation in which [w] is transparent, (14a), though generally speakers prefer the pronunciation in which [w] is opaque, (14b).

(14) /o-βo-ɛɛɛɛ/ ‘truth’
    a. [oβweɛɛɛɛ]
    b. [oβweɛɛɛɛ]

Here we see that the behavior of [w] depends partially on what vowel it is derived from (Cammenga reports that [w] does not show the same variability when it is derived from /u/).

While the back glide, [w], blocks harmony (most of the time at least), the front glide, [j], is not reported to be opaque. This might be related to the fact that [j], unlike [w], is not always derived from a vowel. However, since Cammenga does not include any data that clearly demonstrates that [j] is transparent to harmony, I will not speculate on this further.

The final thing worth noting about the behavior of glides in Ekegusii is that, just like in Pasiego, all of the glides that participate in harmony follow a consonant. That is to say that [w] is never clearly in the margin of a syllable when it blocks harmony. However, unlike in Pasiego, there are

---

17This is an alternate pronunciation of the word used to illustrate the opacity of [u] above.
no examples of [w] appearing between or after vowels, so it is not known whether the glide would also be opaque in these positions.

3.2 Tongue Root Harmony

There are 21 languages in the current survey that exhibit some form of Tongue Root Harmony (TRH): Akan (Dolphyne 1988; O’Keefe 2003), Assamese (Mahanta 2007), Dágáárè (Bodomo 1997), Degema (Kari 2007), Igbo (Anyanwu 1998), Kolokuma Ìjọ (Williamson 1965), Ingessana (Stirtz 2009), Khalkha (Svantesson 1985; Svantesson et al. 2005), Koromfe (Rennison 1997), Kukú (Cohen 2000), Lango (Noonan 1992), Maasai (Cole & Trigo 1989), Menominee (Bloomfield 1962; Walker 2009), Nawuri (Casali 1995b), Ogbronuagum (Kari 2000), Oroch (Tolskaya 2008), Oroqen (Zhang 1995), Somali (Saeed 1999), Pasiego Montañes Spanish, Tangale (Kidda 1993), Wolof (Ka 1994). Among the languages surveyed, TRHs are by far the most numerous and the languages exhibiting this type of harmony are the most typologically diverse (covering 7 of the 14 language families included in the survey).

3.2.1 Neutral Vowels

As in the height harmonies discussed above, all of the logical possibilities with respect to neutral segments are represented in the TRHs in the survey. But unlike in the height harmonies, where only a single language includes vowels that are transparent, all of these possibilities are not only present, but well represented. There are at least 7 languages with opaque vowels (Akan, Assamese, Maasai, Menominee, Nawuri, Tangale, Wolof). There are no fewer than 6 languages with at least one transparent vowel (Menominee, Khalkha, Oroch, Oroqen, Pasiego Montañes Spanish, Wolof). And there are 8 languages with no neutral vowels (Degema, Igbo, Ingessana, Koromfe, Kukú, Lango, Ogbronuagum, Somali).

In all of the languages with an opaque vowel, the harmony blocking vowel is a low vowel. Further, in all of the languages other than Menominee the specific quality of the opaque vowel is the same: [a]. Interestingly, this uniformity in terms of the quality of the blocking vowels is probably not due to shared inheritance, since the TRH languages exhibiting opacity come from 4 different language families (Afro-Asiatic, Indo-European, Niger-Congo, Nilo-Saharan). And although most of the relevant languages are African, this tendency also cannot simply be an areal effect because Assamese is spoken in India. By contrast, the parallel effect in the height harmonies discussed above is almost certainly due to shared genetic inheritance, since all of the height harmony languages with opaque vowels are Bantu.

Tangale, a Chadic language of Nigeria, offers a straightforward example of blocking in a tongue root harmony system. The vowel inventory and relevant data are given in (15) and (16), respectively.

---

18 For the purposes of this paper, I use Tongue Root Harmony as the cover term for harmonies that have been described as [ATR], [RTR], [tense], and [constricted pharynx] harmonies.

19 I say that there are at least 7 languages because it is unclear, based on the sources I used, whether the neutral vowels in Dágáárè and Kolokuma Ìjọ are transparent or opaque.

20 Data taken from van der Hulst & van de Weijer (1995).
In Tangale, all of the non-low vowels, generally, agree for the feature [ATR]. This is true within roots (16a) and in polymorphemic words (16b). As a result, harmony conditions affix allomorphy, with those [+ATR] and [-ATR] vowels that agree in height and backness alternating. The low vowel, which is [-ATR] and has no [+ATR] counterpart, does not alternate; it is neutral, as shown in (16c). More specifically, [a] is opaque, as we can see in (16d). Here we see that when [a] intervenes between a non-low vowel in the root and another non-low vowel in an affix, the affix vowel is always [-ATR], agreeing with [a], regardless of the [ATR] specification of the other non-low vowel.

In all of the TRH systems where [a] blocks agreement, it lacks a [+ATR] counterpart. This correlation is brought into sharp focus in Wolof, a Northern Atlantic Niger-Congo language of Senegal and Gambia, where only the long vowel [a:] is opaque. The Wolof vowel inventory is given in (17) and the data illustrating the behavior of the [a] and [a:] are given in (18)²¹.

²¹Data taken from Ka (1994).
In (18), we see that [a], which has a [+ATR] counterpart, undergoes harmony (18a), whereas [a], which has no counterpart, is immune (18b) and also blocks agreement (18c).

Although the opaque vowels in TRH systems tend strongly not to lexically contrast for the harmonic feature (as is the case with [a] in Tangale and [a] in Wolof), this is not always the case. In Menominee, [a] is opaque\textsuperscript{22}, as in (20), even though it contrasts with [a] for the feature [ATR], as shown in (19).

\begin{center}
\begin{tabular}{l|l|l}
 & +ATR & -ATR \\
\hline
Non-low: & i & u \\
\hline
Low: & a & a \\
\end{tabular}
\end{center}

(19) Non-low: $i$, $u$; Low: $a$, $a$

(20) a. ahku:pi:kat ‘the water extends so far’
b. pri:htahki?taw ‘he sticks his head in’
c. nici:pahkim ‘cook (nom.)’

As shown in (20a), a non-low vowel is normally [+ATR] when it precedes another non-low [+ATR] vowel. However, if [a] appears between non-low vowels, it blocks agreement, as seen in (20b). Crucially, this cannot simply be a matter of harmony only applying when the trigger and target are in adjacent syllables, since it is possible for [a] to intervene between harmonizing non-low vowels, (20c). Here, then, we have a pair of neutral segments that lexically contrast for the harmonizing feature. Instead of being neutral because they lack potential harmonic counterparts, [a] and [a] seem to be transparent and opaque, respectively, because they lack the feature that harmony is parasitic on. In Menominee, harmony applies only to non-low vowels, so the low vowels, [a] and [a], are unaffected by virtue of their being low (or, more importantly, not being non-low). We will see an analogous pattern when we discuss rounding harmony in Khalkha, where [i] is transparent and [u] and [o] are opaque.

Like the opaque vowel, [a], the transparent vowel of Menominee, [a], is exceptional among the vowels that are transparent to TRH. First, it is the only transparent vowel that has a potential harmonic counterpart. The remaining transparent vowels do not lexically contrast for the harmonic feature. This is the situation in Wolof. As seen in (17), high vowels, [i, i, u, u], are all [+ATR]; there are no [-ATR] high vowels. And, as shown in (21), these vowels are transparent to [ATR] harmony. Notice vowels can agree for [ATR] across an intervening high vowel (agreeing vowels in bold).

(21) s\textsuperscript{E}ppiw:O: ‘took out of liquid’
xam\textsuperscript{a}dil\textsuperscript{O:} ‘to make someone impolite’
wer\textsuperscript{a}dise: ‘to become ill at’

As is the case with opacity, there is a single vowel quality that is most often transparent to TRH. While [a] is the most frequent blocker, [i] is the most frequent transparent vowel in the systems surveyed. Among the six languages with at least one transparent vowel, four have transparent [i]: Khalkha\textsuperscript{23}, Oroch, Orogen, and Wolof. In some languages, there is more than one vowel that both fails to undergo and fails to interfere with harmony. In Oroch, a Tungusic language of Russia, in addition to [i], the low vowel [æ] is transparent and, as discussed above, in Wolof, it is not just [i]

\textsuperscript{22}Data are taken from Walker (2009).

\textsuperscript{23}Svantesson \textit{et al.} (2005) show that /i/ reliably surfaces as [I] between [-ATR] vowels. In spite of this, they decide to treat /i/ as neutral to [ATR] harmony because words are always [+ATR] when /i/ appears in the first syllable. I follow them in calling /i/ transparent.
that is irrelevant to [ATR] harmony, but all high vowels. The two languages that show transparency
with a segment other than [i] are Menominee (transparent [a]) and Pasiego (transparent [e]).

In addition to TRHs with transparent and opaque segments, the current survey includes 8
systems without any neutral segments. Just like with height harmony systems, the TRH languages
that do not have neutral segments all have symmetrical vowel inventories. Most of these languages
have 10 vowel systems similar to that of Degema (22a). Igbo, however, has only 8 vowels, as shown
in (22b).

(22) a. Degema vowels
+ATR -ATR
High: i u i u
Mid: e o e o
Low: ø a

b. Igbo vowels
+ATR -ATR
i u i o
ɛ o ø ø

3.2.2 Glides and Diphthongs

Just as we saw with height harmony, glides are almost always transparent to TRH, regardless of
the behavior of the corresponding high vowels. In Khalkha, a Mongolic language, for example, high
vowels show different behavior with respect to [ATR] harmony; [i] is transparent, while [u] and [ø]
are subject to agreement. But the front and back glides exhibit the same behavior: they are both
transparent, as shown in (23)^

(23) a. $t^b\text{uja}$ ‘ray’
ojo ‘tilted’
b. jaw-uŋ-ha ‘to go’ (caus. dpst.)
cow-forow ‘agree’ (pst.)

Here we see that glides do not interrupt harmony; they can appear between [+ATR] vowels (23a)
or [-ATR] vowels (23b). This is the general pattern with glides in the TRH systems surveyed. In
nearly all of the relevant languages, when the crucial data (glides intervening between vowels that
would be expected to agree) is available, it indicates that glides are transparent. Lango, a Nilotic
language of Uganda, is the lone exception to this.

In Lango, a suffix vowel is usually [+ATR] following a [+ATR] vowel in the root, (24a)^
Interestingly, if a suffix begins with a glide, as in (24b), agreement is blocked. But, as we can see,
glides are not the only segments that block harmony, any suffix-initial consonant is opaque, (24c).

(24) a. jm\text{mô} ‘my forehead’
b. wëlðwá ‘our visitor’ *wëlðwô

c. wëlògí ‘their visitor’ *wëlògí

24 Data taken from Svantesson et al. (2005).
Before moving on to diphthongs, I need to point out that, although Lango is the only TRH system in the current survey in which an intervocalic glide clearly participates in harmony, I know of at least one other language not included in the survey where glides are relevant to TRH. In Turkana, a Nilotic language of Kenya and Uganda, non-low vowels are [+ATR] preceding a glide (van der Hulst & van de Weijer 1995). As a result, glides can be seen as blocking and triggering harmony.

In contrast to glides, which are normally transparent or, in the case of Lango, pattern with consonants in being opaque, the high portions of diphthongs typically behave like their monophthong equivalent in the TRHs surveyed (e.g., the second part of [ai] or [au] behaving like monophthong [i] or [u]). In languages where high vowels harmonize, like Dàgáárè, a Gur language of Ghana and Burkina Faso, this means that the high portion of the diphthong agrees with surrounding vowels for [ATR], as shown in (25).

(25) Dàgáárè diphthongs
   a. nimie ‘eyes’
   b. píluŋ ‘whiteness’

Compare this to a language like Oroch where a high vowel is irrelevant to TRH. In Oroch, [i] is transparent to [RTR] harmony, regardless of whether it is a monophthong or appears as part of a diphthong. (26) contains the Oroch diphthong inventory. The [-RTR] diphthongs only appear with [-RTR] vowels and the [+RTR] diphthongs only appear with [+RTR] vowels. Notice that whether a diphthong is [-RTR] or [+RTR] depends on the non-[i] portion; [i] can appear in either type of diphthong.

(26) Oroch diphthongs
   [-RTR]: ia, ai, au, ui, iu
   [+RTR]: ia, ai, au, ui, æi, æu, æa

Another important thing to note about the Oroch diphthong inventory is that while [i] can appear in either type of diphthong, the other transparent vowel, [æ], cannot. It only appears in [+RTR] diphthongs. So although vowel qualities in diphthongs frequently behave like their monophthong equivalents, they do not always. Maasai [ATR] harmony includes a particularly striking example of this.

In Maasai, a Nilotic language of Kenya and Tanzania, non-low vowels harmonize for [ATR]. The vowel inventory and relevant data are given in (27) and (28), respectively.

(27) +ATR       -ATR
    High:   i   u   i   o
    Mid:    e   o   e   e
    Low:    a

(28) a. e-dot-u → e-dot-u 3-pull-MT
    b. i-guran-u → i-guran-u II-play-MT
    c. i-tu-pumu-t-u-a → i-tu-pumu-t-w-a 2-Past-come-Pl-MA-Past

Data taken from Cole & Trigo (1989).
Here we see that, generally, if a [+ATR] vowel appears anywhere in the word all other vowels are [+ATR] as well, (28a). The main source of exceptions to this is [a], which blocks harmony (28b). In addition to being triggered by [+ATR] vowels, harmony is triggered by glides when they appear as the first quality of the diphthongs [ja] and [wa] (28c). Interestingly, when harmony is triggered by a glide, not only is the low vowel [a] opaque, but so are mid vowels (28d).

There are a few things that are especially worth noting about the glide/diphthong induced harmony. First, while it is appropriate to point out that these glides are all derived from vowels, the behavior of the glides cannot be predicted from the underlying vowel. The vowels are [-ATR] underlyingly, so they would not be expected to trigger harmony. Additionally, the specific properties of the glide/diphthong induced harmony cannot be completely accounted for by saying that [w] and [j] are behaving like [i] and [u], the corresponding [+ATR] vowels, since harmony targets different segments depending on which type of segment triggers it. In other words, no appeal to vowels can fully account for the behavior of glides in this case. The other important aspect of the glide/diphthong induced harmony is that it is only triggered by glides that are the first member of the diphthongs [ja] and [wa]. Cole & Trigo (1989) point out that glides in other positions (setting aside a few lexically-specified exceptions) do not generally participate in harmony. This parallels the situation found in Pasiego, discussed above, where glides induce raising, but only when they appear between a consonant and vowel. In both languages, onset glides are irrelevant to harmony while glides that are the first part of a syllable nucleus participate.

### 3.3 Labial Harmony

14 of the languages in the current survey exhibit some form of rounding harmony: Akan, Marash Armenian (Vaux 1998), Azari (Dehghani 2000), Bashkir (Poppe 1964), Burjat (Poppe 1960), Daguara, Karachay (Seegmiller 1996), Khalkha, Nawuri, Oroch, Oroqen, Turkish (Foster 1969), Tuvan (Harrison 2000), Yakut (Krueger 1962). As with height harmony, typologically this is not a very diverse set of languages. 10 of the languages are Altaic, with each branch, Turkic, Tungusic, and Mongolic, being represented by at least two languages. Given how common rounding harmony is in Altaic and how rare it is in other languages, this is perhaps unsurprising. Before discussing neutral vowels, diphthongs, and glides, I’d like to point out that all of these languages exhibit another type of harmony in addition to rounding harmony. For most languages the other harmony is palatal, while for Akan, Daguara, Khalkha, Nawuri, Oroch, and Oroqen it is some type of TRH.

It is especially important to be careful in drawing conclusions about transparent and opaque vowels in labial harmony based on the languages in the current survey. This is because, among the languages included, the only ones in which labial harmony applies iteratively are the Altaic languages. This is relevant because it is only possible to decide whether a neutral segment blocks harmony when it appears between a harmony trigger and a potential target. This is only possible when harmony applies to more than one syllable at a time, as it does in the Turkic, Tungusic, and Mongolic languages. So any conclusions drawn based only on this survey may reflect facts about labial harmony in Altaic languages, not labial harmony in general.

Among the labial harmonies surveyed, in the systems where it is possible to identify neutral vowels (the 10 Altaic languages), every system has at least one neutral segment. More specifically, all of these languages have at least one opaque vowel. In addition to these blocking vowels, two
languages, Khalkha and Buriat, have transparent vowels.

Interestingly, in most cases, vowels that are opaque or transparent to labial harmony lexically contrast for [round]. This is true for both opaque and transparent segments, which Khalkha exemplifies quite clearly. (29) contains the Khalkha vowel inventory and (30) contains the relevant data.

(29) Khalkha vowels
+ATR -ATR
i u o u
e o a o

(30) a. Reflexive suffix (-e/-a/-o/-ɔ)
poor-o ‘kidney’
muur-a ‘eat’
teeʃ-e ‘gown’
b. og-ʊŋ-ʃe ‘to give’ (caus. dpst.)
c. poor-ig-o ‘kidney’ (com. rfl.)

In Khalkha, only non-high vowels trigger and undergo harmony. If the first syllable in a word is a non-high rounded vowel, all subsequent non-high vowels will also be rounded, (30a). If, however, a high rounded vowel appears between the harmony trigger in the first syllable and the potential target later in the word, harmony is blocked, as seen in (30b). Here the opacity of high rounded vowels must be due their being high (or, more importantly, not non-high). It cannot be the case that high rounded vowels are opaque because they do not contrast for the harmonic feature. First, as we can see in (29), [u] does contrast for rounding (though [u] does not). [e] and [o] are harmonic counterparts in this system, so it stands to reason that [i] would be the counterpart to [u]. Second, high rounded vowels already bear the harmonizing feature, so propagating [round] would not require them to alternate with another segment. Finally, high rounded vowels are not the only high vowels that are neutral – so is [i]. Unlike the high rounded vowels, though, [i] is transparent, as shown in (30c). Again, this must be due to lacking the feature that harmony depends on.

4 Results

4.1 Transparent Vowels

4.1.1 Transparent Vowels and Contrast

An often cited generalization about transparent vowels is that they do not lexically contrast for the harmonic feature (see Krämer (2003:104) for a particularly clear statement of this idea). This generalization is taken so seriously that phonologists sometimes attempt to make an explicit connection in their analyses between this lack of contrast and vowel transparency. For example, Baković & Wilson (2000) derive transparency using a targeted version of the same constraint that is responsible

\footnote{For the purposes of the current paper, what exactly a targeted constraint is does not matter, so I will not go into that here. What is important is that a vowel’s transparency and its lack of lexical contrast for the harmonic feature are said to have a common source under this analysis. For readers interested in learning about targeted constraints, (Wilson 2001) is a good starting point.}
for the gap in the inventory corresponding to the vowel that would contrast with the transparent vowel for the harmonic feature.

Given the central role that this generalization sometimes takes in the treatment of transparent vowels, it is important to check and see if it is always true. The results of the current survey clearly indicate that it is not. There are three languages with transparent segments that do lexical contrast for the harmonizing feature: Menominee, Buriat, and Khalkha. In Menominee, [a] neither undergoes nor blocks [ATR] harmony. This is notable because the vowel inventory includes [a], a [+ATR] vowel that [a] would be expected to alternate with in [ATR] harmony. In Buriat and Khalkha, [i] is transparent to rounding harmony and in both languages the corresponding round vowel is present in the language’s inventory. In Buriat, the relevant round vowel is the high front round vowel [y]. In Khalkha, as the result of a vowel shift (Svantesson 1985), the relevant round vowel is the high back round vowel [u].

In each of these languages, the transparent vowel is irrelevant to harmony not because it lacks a harmonic counterpart, but because it lacks the feature that harmony is parasitic on. In Menominee, [ATR] harmony only applies to high vowels. Since [a] is not high, it can be transparent. In Khalkha and Buriat, labial harmony is triggered by and targets non-high vowels only. So, because [i] is high, it can be irrelevant to harmony. I say ‘can be’ here because, just as failing to lexically contrast for the harmonic feature does not guarantee transparency (c.f. opaque [a] in Wolof), lacking the feature that harmony depends on also does not entail transparency. Segments lacking the parasitic feature can also be opaque. In fact, blockers of this type are present in Menominee, Buriat, and Khalkha. Specifically, the expected harmonic counterparts of the languages’ transparent vowels are opaque: [a] in Menominee and high rounded vowels in Khalkha and Buriat.

Although transparent (and opaque) vowels of this type do exist, they appear to be quite rare, which is presumably why they have not been discussed nearly as much as the better known type of neutral vowels. In my survey, these three harmony systems constitute only 1/4 of the systems exhibiting vowel transparency (3 out of 12). Add to this the fact that Khalkha and Buriat are very closely related, so chances are 1/4 is actually an inflated amount; and considering that transparent vowels are already relatively rare—only 12 of the 47 systems that could have had a transparent vowel did have one—it is understandable that such vowels have not attracted a large amount of attention. If my survey is at all representative, likely fewer than 1 in 16 vowel harmony systems have a vowel that is transparent because it lacks the relevant parasitic feature.

4.1.2 Transparent Vowels and Harmony Types

With only 12 harmony systems in the survey exhibiting transparency, it is difficult to say with much certainty whether harmony systems of any particular type tend to include transparent vowels more or less often than any other types. With that said, the results of the current survey do seem to suggest that tongue root harmony systems are more likely to include at least one transparent vowel than any other type of harmony system.

6 of the 18 tongue root harmonies surveyed have at least one vowel that neither undergoes nor blocks agreement: Menominee, Khalkha, Oroch, Oroqen, Pasiego, and Wolof. That means that tongue root harmonies constitute half of the systems that include a transparent segment (6 of 12). But they account for only a little more than 1/4 of the total number of harmony systems that could

\[28\] With all that said, given the amount of attention that Khalkha has received in the harmony literature, it is surprising that our understanding of the nature of transparent segments has not been affected more.

15
have shown transparency (12 of 47). Even if we treat the two Tungusic languages as a single data point because they are very closely related, tongue root harmonies still make up nearly 1/2 of the systems that include transparency (5 of 11), while again only accounting for a bit more than a 1/4 of the total number of the eligible systems (11 of 46).

As for the other types of harmony, none of them clearly display transparency more or less often. Transparency is found in 3 of the 11 palatal harmonies counted: Finnish, Hungarian, and Buriat. All of these languages are so closely related, however, that it is hard to tell whether, for instance, the fact none of the 6 Turkic languages include a transparent vowel is just a fact about Turkic languages, or if it does tell us something about the likelihood of a transparent vowel developing in a palatal harmony system. Similar issues arise with height and labial harmonies. In height harmonies, 1 of 6 systems that could show transparency does, while 2 in 9 show it with labial harmony. However, it is unclear how to interpret these numbers when we consider the fact that 4 of the 5 height harmonies that don’t include transparency are Bantu languages and that both of the labial harmonies that include a transparent segment are Eastern Mongolic (Khalkha and Buriat).

In spite of all the indeterminacy just discussed with the other harmony types, it is definitely notable that tongue root harmonies seem to show the highest rate of occurrence of transparent segments. So, even with its current flaws in this regard, the survey has something useful to add to our understanding of different types of harmony.

4.2 Diphthongs and Glides

4.2.1 The Transparency of Glides

In contrast to vowels, where transparency is the exception rather than the rule, glides are nearly always transparent. Coincidentally enough, in the current survey, glides were found to participate in almost exactly the same number of harmony systems as vowels were found to be transparent. Glides were found to participate in 10 of the 47 systems\(^{29}\), while vowels failed to participate in 12 of 47.

These 10 cases of glides participating can be put into three bins. There are those that block, including intervocically, but are patterning with consonants. For example, in Lango, [ATR] harmony is blocked by the presence of a suffix-initial glide, but it is also blocked by the presence of any root-initial consonant. Here then the exceptional participation of the glide can be accounted for by saying that it is just behaving like a consonant. Similar stories can be told with blocking by glides in Warlpiri ([w] and [p] block), in Dhaasanac ([j] and palatal consonants block\(^{30}\)), and in Arapaho ([j] and all non-velar, non-glottal consonants block).

The second category consists of glides that trigger or block harmony, but are only reported to do so when they appear between a vowel and a consonant. This group includes Pasiego Montañes Spanish, in which a glide appearing between a consonant and a glide in stressed syllable will trigger raising. The idea with these exceptions is that perhaps it would be more appropriate to consider these glides to be part of the nucleus. As we will discuss in the next section, it is not all that

\(^{29}\)There is actually another instance of a glide seeming to participate in harmony. Poppe (1960) mentions in footnote 4 of Chapter 1 that the sequence [je:] never occurs, with [je:] surfacing instead. This would have the effect of blocking rounding harmony because vowels are unrounded following [e:]. I have not listed this as an exceptional glide, however because this is a co-occurrence restriction between two specific segments, rather than the glide and rounded vowels in general.

\(^{30}\)High vowels also block in Dhaasanac, but this includes both front and back vowels, and there is no indication that [w] is opaque.
exceptional for the high portion of a diphthong to participate in harmony, so this would account nicely for the behavior of these glides.

The final group is the only obviously truly exceptional category. There are three cases of [w]’s in labial harmony participating in rounding harmony. This can be blocking or triggering. In Bashkir, where labial harmony only affects mid vowels, [w] is opaque. While in Nawuri and Karachay, [w] triggers rounding. Karachay offers an especially nice example of this. In Karachay, high vowels are usually only rounded following other rounded vowels, as shown in (31a)\(^{31}\). In (31b) we see that [w] also triggers rounding on a following vowel. Notice that [w] triggers rounding even when it is not adjacent to the glide (as in ‘well-to-do’).

\[
(31)\quad \begin{align*}
a. & \quad 1SG Possessive suffix (-im/-üm/-ɨm/-um) \\
& \quad tîlim \quad \text{‘my tongue’} \\
& \quad butum \quad \text{‘my leg’} \\
& \quad tawum \quad \text{‘my mountain’} \\
& \quad injïwsūz \quad \text{‘well-to-do’} \\
\end{align*}
\]

Clearly there is something different about [w] in labial harmony. This is the only type of glide that is clearly consonantal and participates in harmony when no other consonant does. What’s more, there are three examples of this behavior. Clearly some work needs to be done to determine why, for instance, [j] in palatal harmony does not show the same effects. For now, I will have to leave this issue open\(^{32}\).

4.2.2 The Participation of Diphthongs

Unlike glides that appear in syllable margins, especially onset, the high portion of glides tends to behave as you would expect based on its monophthong equivalent. Often there are languages like Yakut where both qualities harmonize in every harmony system or like Khalkha where the high portion of the glide is transparent, but that is completely consistent with the behavior of the corresponding high vowel.

There are, of course, exceptions to this. Recall that in Maasai, the high portion of the diphthongs [ja] and [wa] trigger [ATR] harmony, which is what you would expect if they were high [+ATR] vowels. However, whereas [ATR] harmony triggered by vowels is only blocked by [a], [ATR] harmony triggered by a diphthong is also blocked by a mid vowel. This and other differences between the behavior of the high portion of diphthongs and vowels suggests that although the glide-like portion of a diphthong is more vowel-like than a glide outside of a syllable nucleus, it is still different from a monophthong.

\[^{31}\text{Data from Seegmüller (1996).}\]
\[^{32}\text{This issue is all the more intriguing when we consider the fact that there is a language like Turkana, in which glides trigger [ATR] harmony. Given that this is possible, why doesn’t it happen as often as glides participating in labial harmony?}\]

17
5 Conclusion

In this prospectus, I have reviewed some of the findings of an initial survey of vowel harmony with focus primarily on transparent (and opaque) behavior of both vowels and glides. In addition to the unsurprising finding that vowels tend quite strongly not to be transparent, while glides, at least in syllable margins, are usually transparent, there are some interesting results. The first notable result is that tongue root harmonies seem to include transparent vowels more often than other types of harmonies. For now I have no explanation for this, though the next obvious step is to delve into the existing literature on the articulatory and acoustic phonetics of ATR, especially on [i] which is so often the transparent. The second notable result is that [w] seems to participate in labial harmony with relative frequency. This is potentially surprising given that we did not find any other unambiguous examples of a glide in a syllable margin, and only that glide, participating in harmony. This raises interesting questions about the differences not only between labial and palatal glides, but also between labial harmony systems and other types of harmony systems.
Appendices

A Languages in Survey

<table>
<thead>
<tr>
<th>Language</th>
<th>Family</th>
<th>Location(s)</th>
<th>Source(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arapaho</td>
<td>Algonquian (Algonquian)</td>
<td>USA</td>
<td>Cowell &amp; Moss (2008)</td>
</tr>
<tr>
<td>Armenian (Marash)</td>
<td>Indo-European</td>
<td>Turkey</td>
<td>Vaux (1998)</td>
</tr>
<tr>
<td>Armenian (Karchevian)</td>
<td>Indo-European</td>
<td>Armenia</td>
<td>Vaux (1998)</td>
</tr>
<tr>
<td>Assamese</td>
<td>Indo-European</td>
<td>India</td>
<td>Mahanta (2007)</td>
</tr>
<tr>
<td>Asari</td>
<td>Turkic</td>
<td>Iran, Iraq</td>
<td>Dehghani (2000)</td>
</tr>
<tr>
<td>Bashkir</td>
<td>Turkic</td>
<td>Russia</td>
<td>Poppe (1964)</td>
</tr>
<tr>
<td>Buriat</td>
<td>Mongolic</td>
<td>Russia</td>
<td>Poppe (1960)</td>
</tr>
<tr>
<td>Chamorro</td>
<td>Austronesian (Western Malayo-Polynesian)</td>
<td>Guam</td>
<td>Topping (1973)</td>
</tr>
<tr>
<td>Chichewa</td>
<td>Niger-Congo (Bantu)</td>
<td>Mozambique, Malawi, Zambia, Zimbabwe</td>
<td>Bentley &amp; Kulemeka (2001)</td>
</tr>
<tr>
<td>Chukchi</td>
<td>Chukotko-Kamchatkan</td>
<td>Russia</td>
<td>Spencer (1989)</td>
</tr>
<tr>
<td>Cyao</td>
<td>Niger-Congo (Bantu)</td>
<td>Malawi, Mozambique, Tanzania</td>
<td>Ngenga (2000)</td>
</tr>
<tr>
<td>Dágáré</td>
<td>Niger-Congo (Bantu)</td>
<td>Burkina Faso, Ghana</td>
<td>Bodomo (1997)</td>
</tr>
<tr>
<td>Desano</td>
<td>Tucanoan</td>
<td>Colombia, Brazil</td>
<td>Kaye (1970)</td>
</tr>
<tr>
<td>Dhaasannac</td>
<td>Afro-Asatic (Cushitic)</td>
<td>Ethiopia</td>
<td>Tosco (2001)</td>
</tr>
<tr>
<td>Djingili</td>
<td>Australian (West Buryky)</td>
<td>Australia</td>
<td>Pensaflini (1997)</td>
</tr>
<tr>
<td>Efik</td>
<td>Niger-Congo (Bantu)</td>
<td>Nigeria</td>
<td>Ward (1933)</td>
</tr>
<tr>
<td>English</td>
<td>Indo-European</td>
<td>Scotland</td>
<td>Fitzgerald (2002); Paster (2004)</td>
</tr>
<tr>
<td>Evenki</td>
<td>Altaiic (Tungusic)</td>
<td>Russia</td>
<td>Nedjalkov (1997)</td>
</tr>
<tr>
<td>Finnish</td>
<td>Uralic (Finno-Ugric)</td>
<td>Finland</td>
<td>Sulkala &amp; Karjalainen (1992)</td>
</tr>
<tr>
<td>Hungarian</td>
<td>Uralic (Finno-Ugric)</td>
<td>Hungary</td>
<td>Reneski et al. (1998)</td>
</tr>
<tr>
<td>Ijo (Kolokuma)</td>
<td>Niger-Congo (Ijoid)</td>
<td>Nigeria</td>
<td>Williamson (1965)</td>
</tr>
<tr>
<td>Ingesiana</td>
<td>Nilo-Saharan (Eastern Sudanic)</td>
<td>Sudan</td>
<td>Stürte (2009)</td>
</tr>
<tr>
<td>Karachay</td>
<td>Turkic</td>
<td>Russia</td>
<td>Sengmiller (1996)</td>
</tr>
<tr>
<td>Kera</td>
<td>Afro-Asatic (Chadic)</td>
<td>Chad</td>
<td>Pearce (2003)</td>
</tr>
<tr>
<td>Khalkha</td>
<td>Mongolic</td>
<td>Mongolia</td>
<td>Svanström (1985)</td>
</tr>
<tr>
<td>Kham</td>
<td>Tibeto-Burman (Bodic)</td>
<td>Nepal</td>
<td>Watters (2002)</td>
</tr>
<tr>
<td>Kimatumbi</td>
<td>Niger-Congo (Bantu)</td>
<td>Tanzania</td>
<td>Odden (1996)</td>
</tr>
<tr>
<td>Kinyarwanda</td>
<td>Niger-Congo (Bantu)</td>
<td>Rwanda</td>
<td>Kimenyi (1979)</td>
</tr>
<tr>
<td>Koromfe</td>
<td>Niger-Congo (Gur)</td>
<td>Burkina Faso, Malia</td>
<td>Rennison (1997)</td>
</tr>
<tr>
<td>Kukü</td>
<td>Nilo-Saharan (Nikotic)</td>
<td>Sudan, Uganda</td>
<td>Cohen (2000)</td>
</tr>
<tr>
<td>Lungo</td>
<td>Nilo-Saharan (Nikotic)</td>
<td>Uganda</td>
<td>Noonan (1992)</td>
</tr>
<tr>
<td>Menominnee</td>
<td>Algonquian (Algonquian)</td>
<td>USA</td>
<td>Bloomfield (1962); Walker (2009)</td>
</tr>
<tr>
<td>Nawuri</td>
<td>Kwa</td>
<td>Ghana</td>
<td>Casali (1995a); Casali (1995b)</td>
</tr>
<tr>
<td>Oroch</td>
<td>Altaiic (Tungusic)</td>
<td>Russia</td>
<td>Toksaya (2008)</td>
</tr>
<tr>
<td>Oroqon</td>
<td>Altaiic (Tungusic)</td>
<td>China</td>
<td>Zhang (1995)</td>
</tr>
<tr>
<td>Pendah</td>
<td>Austronesian (Sulawesi)</td>
<td>Indonesia</td>
<td>Quick (2007)</td>
</tr>
<tr>
<td>Somali</td>
<td>Afro-Asatic (Cushitic)</td>
<td>Somalia</td>
<td>Sasse (1996)</td>
</tr>
<tr>
<td>Spanish</td>
<td>Indo-European</td>
<td>Spain</td>
<td>McCarthey (1984)</td>
</tr>
<tr>
<td>Tangale</td>
<td>Afro-Asatic (Chadic)</td>
<td>Nigeria</td>
<td>kidd (1993)</td>
</tr>
<tr>
<td>Turkish</td>
<td>Turkic</td>
<td>Turkey</td>
<td>Foster (1999)</td>
</tr>
<tr>
<td>Tuvaan</td>
<td>Turkic</td>
<td>Russia</td>
<td>Harrison (2000)</td>
</tr>
<tr>
<td>Warlpiri</td>
<td>Australian (Pama-Nyungan)</td>
<td>Australia</td>
<td>Nash (1980)</td>
</tr>
<tr>
<td>Yakut</td>
<td>Turkic</td>
<td>Russia</td>
<td>Krueger (1962); Sasa (2009)</td>
</tr>
</tbody>
</table>
### B Languages with Neutral Vowels

<table>
<thead>
<tr>
<th>Language</th>
<th>Type of Harmony</th>
<th>Transparent</th>
<th>Opaque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish (Pasiego Montañes)</td>
<td>Height</td>
<td>a, æ</td>
<td>none</td>
</tr>
<tr>
<td>Chichewa</td>
<td>Height</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Ciyao</td>
<td>Height</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Ekegusii</td>
<td>Height</td>
<td>none</td>
<td>i, u, a</td>
</tr>
<tr>
<td>Kimatuumbi</td>
<td>Height</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Kham</td>
<td>Height</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Ikalanga</td>
<td>Height</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Warlpiri</td>
<td>Other</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Dhaasanac</td>
<td>Other</td>
<td>none</td>
<td>high vowels</td>
</tr>
<tr>
<td>Djingili (a.k.a. Jingulu)</td>
<td>Other</td>
<td>none</td>
<td>i, u</td>
</tr>
<tr>
<td>Armenian (Agulis)</td>
<td>Palatal</td>
<td>none</td>
<td>i, e</td>
</tr>
<tr>
<td>Armenian (Karchevian)</td>
<td>Palatal</td>
<td>none</td>
<td>i, e, ε</td>
</tr>
<tr>
<td>Buriat</td>
<td>Palatal</td>
<td>i, iː</td>
<td>none</td>
</tr>
<tr>
<td>Finnish</td>
<td>Palatal</td>
<td>i, e</td>
<td>none</td>
</tr>
<tr>
<td>Hungarian</td>
<td>Palatal</td>
<td>i, iː, eː, (ε)</td>
<td>none</td>
</tr>
<tr>
<td>Buriat</td>
<td>Rounding</td>
<td>i, iː, e, (y)</td>
<td>yː, uː, ei [εː], yi [yː], (u)</td>
</tr>
<tr>
<td>Khalkha</td>
<td>Rounding</td>
<td>i</td>
<td>u, ū(underlying Ei [ɛː])</td>
</tr>
<tr>
<td>Oroch</td>
<td>Rounding</td>
<td>none</td>
<td>i, æ, ū</td>
</tr>
<tr>
<td>Azari, Iranian (South Azari)</td>
<td>Rounding</td>
<td>none</td>
<td>low vowels</td>
</tr>
<tr>
<td>Bashkir</td>
<td>Rounding</td>
<td>none</td>
<td>low vowels</td>
</tr>
<tr>
<td>Oroqen</td>
<td>Rounding</td>
<td>none</td>
<td>i, u, ū</td>
</tr>
<tr>
<td>Tangale</td>
<td>TRH</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Menominee</td>
<td>TRH</td>
<td>a</td>
<td>æ</td>
</tr>
<tr>
<td>Khalkha</td>
<td>TRH</td>
<td>i</td>
<td>none</td>
</tr>
<tr>
<td>Oroch</td>
<td>TRH</td>
<td>i, æ</td>
<td>none</td>
</tr>
<tr>
<td>Assamese</td>
<td>TRH</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Spanish (Pasiego Montañes)</td>
<td>TRH</td>
<td>e</td>
<td>none</td>
</tr>
<tr>
<td>Akan</td>
<td>TRH</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Nawuri</td>
<td>TRH</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Wolof</td>
<td>TRH</td>
<td>i, iː, uː</td>
<td>aː</td>
</tr>
<tr>
<td>Maasai</td>
<td>TRH</td>
<td>none</td>
<td>a</td>
</tr>
<tr>
<td>Maasai (diphthong induced)</td>
<td>TRH</td>
<td>none</td>
<td>a, e, o</td>
</tr>
<tr>
<td>Oroqen</td>
<td>TRH</td>
<td>i</td>
<td>none</td>
</tr>
</tbody>
</table>
C  Sample Language Report

Language: Khalkha
Family: Altaic (Mongolic)
Locations: Mongolia
Langcode: khk


Monophthong Inventory: i,e,a,u,o,ɔ
Diphthong Inventory: ai,ui,oi,ei
Diphthongs derived or underlying: Underlying
Glide Inventory: j,w
Glide portion behaving as vowel or consonant: Consonant (See Svantesson, et al. 2005 Ch 2.5 re:[w] and Ch 6.5 re:[j])
Stress: None
Syllable structure: (C)V(V)(C)(C)(C)
Vowel length: Long vowels occur only in the first syllable (e in initial syllables is always long)
Morphological facts: Suffixing, Reduplication

Harmony Type: ATR
Dependent feature: None
Transparent Vowels: i
Opaque Vowels: None
Behavior of Diphthongs: The non-high portion of diphthongs behave just like their monophthong equivalents. The high portion is transparent.
Behavior of Glides: Transparent
Domain of harmony: Non-compound word
Directionality: Left-to-right

Description: All harmonic vowels in a word are + or - ATR.

Harmonic vowels:
+ATR vowels: e,u,o
-ATR vowels: a,u,ɔ

[i], which has no -ATR counterpart, is transparent (can occur between -ATR vowels). If [i] is the first vowel of the word, all subsequent vowels are +ATR.

Both glides can occur in + or - ATR words.

Harmony Type: Rounding
Dependent feature: Height
Transparent Vowels: i
Opaque Vowels: u,o (e: that alternates with diphthongs)
Behavior of Diphthongs: The non-high portion of diphthongs behave just like their monophthong equivalents. The high portion is transparent.
Behavior of Glides: Transparent
Domain of harmony: Non-compound word
Directionality: Left-to-right

Description: A non-high vowel is rounded iff the preceding vowel is another non-high rounded vowel.

[i] is transparent (can occur between two non-high rounded vowels). In the spoken language, [i] is sometimes opaque (though more often in +ATR words).

High rounded vowels block harmony (as monophthongs or as the first quality of a diphthong).
Both glides can occur between non-high rounded vowels.
References


Kaisse, Ellen M., & Susannah V. Levi. 2004. Vowel harmony: nucleus to nucleus or vocalic node to vocalic node? Talk presented at the 78th annual meeting of the Linguistics Society of America, Boston, MA.


