Lingua 67 (1985) 283–327. North-Holland

VOWEL HARMONY SHIFT IN MONGOLIAN

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Received July 1985

It has generally been assumed that Mongolian has vowel harmony of the palatal (front–back) type, but in this article I will present acoustic data from several Mongolian dialects, which show that there has been a shift in the phonetic basis of vowel harmony from palatality in Classical Mongolian to pharyngeality in modern East Mongolian (including Khalkha and Inner Mongolian).

I will also treat Mongolian vowel harmony and the vowel harmony shift in terms of generative phonology. As far as I know, this is the first time a vowel harmony shift has been descripted in detail, and the description gives rise to several problems which cannot be solved using Chomsky and Halle's feature system or the different amendments to it, which have been proposed to deal with pharyngeal harmony. For this reason I have adopted the feature system worked out by Sidney Wood, based on cross-linguistic studies of vowel articulation, within which the vowel harmony shift can be described as a rule simplification.

1. Background

According to Poppe (1965), the Mongolic branch of the Altaic language family can be divided into two major sub-branches, East and West Mongolian. There are also a number of small languages, which cannot be included in any of these branches, such as Dagur, Monguor (Tŭ), Dōngiāng (Santa), East Yugur, Baonan, and Moghol. West Mongolian, or Oirat includes Kalmyk and some dialects spoken in Xīnjiāng and Qīnghǎi in China. East Mongolian consists of Buriat (in the Buriat ASSR and also Bargu Buriat in Inner Mongolia) and Mongolian proper (Khalkha and the central dialects of Inner Mongolia).

The Mongolian writing system has been used at least since the 13th Century, and the written language is close to Ancient Mongolian, the ancestor of all Mongolic languages. This written language, Classical Mongolian, is still used by the Mongols of Inner Mongolia, but the Khalkha Mongols in the Mongolian People's Republic now use a Cyrillic-based script, as do the Buriats and Kalmyks in the USSR. The Oirats used the Classical Mongolian

written language until it was replaced by another writing system, the 'Clear script' introduced by Zaya Pandita in 1648. This is based on the old script and is still used by the Oirats in China.

Classical (written) Mongolian had the following vowel system:

i	y		u
e	ø	a	o

It is generally assumed that the vowels were pronounced approximately as the IPA values of the letters used for transcribing them (see e.g. Poppe (1955)). The vowels which are written with the IPA symbols *y* and *ø* here are usually transcribed as *ü* and *ö*.

There was front–back vowel harmony, and the vowel harmony rule says that a word could contain vowels from only one of the classes of front vowels (*e*, *y*, and *ø*) or back vowels (*a*, *u*, and *o*). The (phonetically front) vowel *i* is neutral and can occur in any position both in back-vocalic and front-vocalic words. Unlike modern East Mongolian, Classical Mongolian did not have rounding harmony, except in the very restricted sense that *o* and *ø* could appear in non-initial syllables only if the first syllable also had the same vowel (or, in a few cases, *i*).

Vowel harmony applies to roots and suffixes alike, and causes suffixes to have different vowels depending on the vowel harmony class of the root. In suffixes, *a* and *u* alternate with *e* and *y*, respectively. *i* remains unchanged, and *o* and *ø* do not occur in suffixes.

Ancient Mongolian had the same vowel system as Classical Mongolian, except that there probably was a back vowel **ɨ*, which merged with **i* in Classical Mongolian. There seems to be no trace of **ɨ* in East or West Mongolian, so as far as the vowel system is concerned, Classical Mongolian can be regarded as the ancestor of these languages (except that the beginning of rounding harmony found in Classical but not in Ancient Mongolian does not occur in modern West Mongolian).

The vowel system of Classical Mongolian has apparently not been retained in any modern Mongolian dialect. This is due to several phonological processes which have restructured the vowel systems more or less radically. In East Mongolian, some back vowels have been fronted by umlaut, and some front vowels have been backed (see below for details). The vowel harmony classification of each word has been retained, however, so that originally front-vocalic words now contain back vowels and *vice versa*. Umlauting has also taken place in West Mongolian, but there the harmony class has been changed in those words, where the first vowel has been fronted.

i-umlaut: preceding vowel becomes high/ raised due to following /i/

In this article I will use acoustic data to show that vowel harmony in East Mongolian is no longer of the fronting type. The most probable interpretation of the data is that the phonetic basis of vowel harmony has shifted from front–backness to pharyngeality (probably normal, or somewhat expanded, vs. constricted pharynx).

The only way to prove this conclusively would be to make a cineradiographic investigation, which has unfortunately not been possible for me. Thus I will argue indirectly from acoustic data. I will also show that with this solution a concrete generative account for the vowel harmony can be given, and that the vowel harmony shift can be motivated in articulatory terms.

My data come from two Inner Mongolian dialects and from Khalkha, but apparently the vowel harmony shift has taken place in all East Mongolian languages, including also Buriat, but not in West Mongolian (Oirat). For comparison, I will also outline the vowel harmony system of Kalmyk, basing myself on standard sources. These languages represent three different types as regards vowel changes: in Khalkha there has been backing but not umlauting (at least not on the phonemic level), in Kalmyk, there has been umlauting but no backing, and in Inner Mongolian (at least in Čahar, Baarin, and Horčin), both these processes have occurred.

2. Previous treatments of Mongolian vowel harmony

Western mongolists who have worked with the spoken (East) Mongolian languages have generally had a historical perspective, and have equated the modern vowel harmony system with the classical one, although they have noted the phonetic difference. Buraev (1959) says that the terms 'front' and 'back' traditionally used by mongolists are not correct for Buriat and uses 'soft' (*mjagkij*) and 'hard' (*tvërdyj*) instead. Stuart and Haltod (1957: 93) and Bosson and Unensečen (1962a) also express doubts towards these labels.

According to Činggeltei (1983), an analysis of the vowel harmony classes as lax and tense (*sōng* and *jǐn* in Chinese) was arrived at after dialect surveys in Inner Mongolia in 1955–1956, and this analysis was gradually accepted in Inner Mongolia (it is used e.g. by Dobu (1983,1984)), and also by some scholars from the Mongolian People's Republic and the Soviet Union. Nasunbayar et al. (1982) and other scholars writing in Mongolian call the vowel harmony classes *köndei* 'hollow' and *čingya* 'firm', and neutral vowels are referred to as *sayarmay* 'neutral'.

Činggeltei (1983) says that 'when tense vowels are produced, the upper part of the throat is tensed and the tongue root is retracted'. He says that the

traditional Mongolian terms for the vowel harmony classes, *eme* 'female', *ere* 'male' and *eresü* 'hermaphrodite' (i.e. neutral) refer to laxness and tenseness (rather than frontness and backness).

Arguments based on Mongolian vowel harmony have recently been used in several phonological controversies. The question of how to treat vowel harmony in generative phonology is one of these. Lightner (1965) used Classical Mongolian data to argue for an abstract root marker 'GRAVE' which determines both vowel harmony and the alternation between velar (*k* and *g*) and uvular (*q* and *γ*) consonants. He overlooked, however, the fact that *k* and *g* may appear also in back harmonic words (before the neutral vowel *i*), and his suggestion has not been widely accepted. This was pointed out by Zimmer (1967) (but the same mistake was repeated by Odden (1980) and Yamada (1983)).

Zimmer considered and Bach (1968) proposed a representation where only the first vowel is specified for the harmonizing feature, and the following vowels are given the correct value of this feature by an assimilation rule. This was proposed for Khalkha by Hamp (1980), and Binnick (1980) used both Classical and Khalkha data to argue for this kind of solution, which agrees with the traditional view among altaicists.

A prosodic approach to vowel harmony, in many ways similar to Lightner's (and to Hamp's (1958) structuralistic analysis of Classical Mongolian vowel harmony), was taken up by Clements (1977), who proposed the use of autosegmental phonology for describing vowel harmony. This was applied to Khalkha Mongolian by Chinchor (1979), and by Steriade (1979), who combined autosegmental and metric phonology in her analysis. The prosodic approach was criticized by Anderson (1980), who argues for a segmental iterative description of vowel harmony in Mongolian and other languages, but the autosegmental treatment was defended by Leben (1982). A metric phonological analysis was applied to Khalkha also by Halle and Vergnaud (1981) and by Steriade (1981).

A second, related controversy concerns abstractness in phonology. Several authors have suggested that neutral vowels (which may occur in words from both harmony classes) have two different underlying forms, which are merged unconditionally at some stage of the derivation. Such solutions were argued against by Kiparsky (1968), who used Classical Mongolian as one example, but have been used by several authors, including Vago (1973) and Yamada (1983), who makes a rather extreme use of abstract underlying vowels in Khalkha.

Mongolian data has also been used in a discussion about what kind of material may intervene between the focus (the changed segment) and determi-

nant (the segment which causes the change) in a phonological rule which acts at a distance. See Odden (1977, 1980), Jensen and Stong-Jensen (1979), and Yamada (1983).

Although the historical changes which have led to a restructuring of the vowel systems in modern Mongolian are well-known and described in standard sources (see section 5), they have been rather unnoticed by general phonologists writing about modern Mongolian. Unlike those scholars who are familiar with the spoken languages, they have not hesitated to equate the modern and classical vowel harmony systems. This is often done tacitly, but Odden (1980: 280) says explicitly that 'Classical Mongolian Vowel Harmony ... has remained virtually unchanged in the historical development of the modern languages over the past half millennium' (cf. also Binninck (1969: fn. 5)).

Thus, one of the most often discussed Mongolian languages is a non-existing 'Khalkha', having the same vowel system as Classical Mongolian, with fronting harmony preserved, but with added rounding harmony. (In fact, it seems that rounding harmony has developed only in those Mongolic languages where fronting harmony has been replaced by pharyngeal harmony.)

The main difference between the modern Khalkha and the classical vowel systems is that the classical front rounded vowels [y] and [ø] have developed into back vowels [u] and [ɵ], respectively. Probably due to the lack of experimental phonetic investigations, and also because of the authority of Ramstedt's (1903) description of Khalkha, Western mongolists have generally described these vowels as central (or 'mixed'). General phonologists have chosen to interpret 'central' as 'front', and have ignored other differences from Classical Mongolian found in descriptions of the modern languages. By this double misconception, the Khalkha and classical vowel systems become equal, and the neat fronting vowel harmony of Classical Mongolian is preserved.

Some authors have noted that originally back vowels have been fronted by umlaut in some modern Mongolian languages, while the harmony class of the word has remained unchanged, and to account for this they have suggested the use of abstract underlying forms, where the vowels have the 'correct' vowel harmony class (i.e., [+back]). See Binninck (1980: 125), Clements and Sezer (1982: 251) and, for Buriat, Vago (1973: 583).

Others conclude that the vowel changes have destroyed the phonetic basis of vowel harmony, which has become purely classificatory. For instance, Anderson (1980: 8) says of the vowel harmony of the (Inner Mongolian) Horčin dialect (similar to Čahar described below), that 'It is difficult to imagine a system with less "phonetic motivatedness"'.

The only published experimental phonetic data on Mongolian vowels I know of are some duration measurements for Kalmyk given by Ramstedt (1935), Buraev's (1959) X-ray study of Buriat, Jõo's (1973, 1975, 1976) acoustic vowel studies of Khalkha and Čahar, and an investigation of Buriat intonation by Bajčura (1978). Buraev concludes that vowel harmony in Buriat is not of the front–back type, while Jõo's result is that Mongolian vowel harmony is 'diagonal'. Neither author gives any alternative articulatory interpretation of Mongolian vowel harmony.

As far as I know, no experimental phonetic data have been published by Inner Mongolian scholars in support of their tense/lax analysis, but the results and the interpretation presented here basically agree with that analysis.

3. Acoustic investigation

3.1. The vowels of Inner Mongolian

According to Činggeltei (1979), Inner Mongolian can be divided into Čahar, Baarin, Horčin, Harčin, Ordos, and Ejin. The Čahar dialect as spoken in Šuluun Höh Banner (Siluγun Köke Qosiγu; Zhènglán Qí in Chinese) has been designated as the standard Inner Mongolian dialect (Nasunbayar et al. (1982: 16)), and several books and articles which describe or give data from this dialect have appeared. They differ, however, especially as regards the vowels. Thus, from Dobu (1981, 1983), Nasunbayar et al. (1982), and Sūn (1983), four different versions of the vowel system can be extracted. A fifth version can be found in Bürintegüs (1977), but exactly what dialect is described there is not clear, although the foreword acknowledges help from 'poor herdsmen from Šuluun Höh and Baarin Right Banners (Baγarin Baraγun Qosiγu)'. Also the phonemic description of 'Modern Standard Mongolian' by Stuart and Haltod (1957) is based on the speech of a native of Šuluun Höh.

The most comprehensive description is that of Dobu (1983), and all Šuluun Höh forms cited here are taken from this book. He gives the following vowel system:

i			u
ɪ			ʊ
e	ø	ə	ɵ
æ	œ	a	ɔ

All vowels can be both long and short, except /ø:/ and /e:/ which are always long. These two vowels do not occur in the first syllable of a word.

The vowels given here as *ɵ* and *æ* are written *o* and *ɛ* by Dobu. Dobu also has a vowel [ʏ] (and [y] appearing only in the diphthong [yi]). These are not phonemic, being the umlauted allophones of /ɷ/ and /u/. They are found only in the first syllable of a word, followed by a palatalized consonant (or /i/, /ɪ/). Short [æ] and [œ] are umlauted allophones (of /a/ and /ɔ/), but the corresponding long vowels /æ:/ and /œ:/ contrast with /a:/ and /ɔ:/. The two harmony classes in the Šuluun Höh dialect are:

(1) i e ø ə ɵ u
(2) ɪ æ œ a ɔ ɷ

In a given word, only vowels from one of these classes can occur. There is also rounding harmony, which will be described below.

3.2. Formant frequencies

In September 1984 I recorded a word-list illustrating the vowels with two male Inner Mongolian informants at the Central Institute for Nationalities in Běijīng.

The first informant was a native of Baarin Right Banner (Baγarin Baraγun Qosiγu), and the second came from the Yuèjìn People's Commune in Šiliingol

Table 1
Recorded Mongolian words.[1]

Vowel	Inner Mongolian	Khalkha	
[i]	či:	či:	'you'
[ɪ]	garɪ:g	garɪ;g	'hand (acc.)'
[e]	ərbə:xe:	erve:xi:	'butterfly'
[æ]	æ:l	–	'household'
[œ]	œ:	–	'year'
[ə]	ərbə:xe:	–	'butterfly'
[a]	ta:	ta:	'you (pl.)'
[u]	du:	du:	'younger brother'
[ɷ]	dɷ:	dɷ:	'voice'
[ɵ]	tɵ:	tɵ:	'finger-span'
[ɔ]	tɔ:	tɔ:	'number'

[1] Inner Mongolian [æ] and [œ] correspond to Khalkha diphthongs. For the problem of the phonemic status of Khalkha [ɪ], see section 4.2.

(Sili-yin Γool). In Činggeltei's classification, the dialects of the informants are Baarin and Čahar (Šiliingol or Üjemčin (Üjümüčin) subdialect).

Words illustrating each (long) vowel were chosen from Dobu (1983) (see table 1). Although the Šuluun Höh (Čahar) dialect described by him is not exactly the same as that of my informants, there are probably not any important differences in the vowel systems. Apparently, there is no /ø:/ in the dialects of my informants. It is rather marginal in Šuluun Höh, and only about five words with this vowel are given in the text and vocabulary in Dobu's book.

In June 1985 I had the opportunity to record the same word-list with a male Khalkha speaker, who is a native of Bajanhongor in the central part of the Mongolian People's republic. The recording was made in Lund, Sweden.

Each word was read three times by each informant, and the recordings were made on a high quality cassette recorder. Spectrograms were made on a Kay Digital Sonagraph, and the first three formants of each vowel token were measured. The results are given in table 2 and in figures 1–3.

Table 2
Formant frequencies of Mongolian vowels.

Vowel	Baarin			Šiliingol			Khalkha		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
[i]	350	2290	3060	400	2145	2745	380	2000	2875
	345	2275	3085	400	2090	2745	320	1910	2840
	325	2270	3020	425	2115	2750	400	2075	2755
[ɪ]	405	2305	3055	510	2185	2730	505	1805	2730
	395	2240	3055	490	2120	2650	500	1790	2755
	380	2300	3115	475	2085	2560	535	1775	2675
[e]	555	1835	2730	480	2030	2555	470	1510	2175
	540	1810	2550	495	1945	2515	480	1510	2175
	560	1855	2700	500	1880	2500	465	1415	2115
[æ]	640	1685	2760	690	1650	2585			
	615	1650	2795	715	1735	2600			
	610	1670	2875	700	1730	2655			
[œ]	510	1860	2605	675	1215	2450			
	515	1965	2650	690	1260	2415			
	570	1905	2655	700	1205	2375			
[ə]	425	1145	2525	375	1480	2485			
	455	1180	2590	375	1575	2440			
	460	1270	2510	440	1610	2480			
[a]	910	1395	2730	880	1290	2370	815	1335	2925
	885	1325	2720	820	1305	2410	755	1405	2750
	900	1400	2710	780	1280	2390	835	1380	2760

Vowel	Baarin			Šiliingol			Khalkha		
	F1	F2	F3	F1	F2	F3	F1	F2	F3
[ɵ]	505	960	2685	460	1005	2635	495	1070	2115
	500	960	2675	435	1060	2665	480	1080	2110
	475	970	2690	430	1040	2540	450	1145	2145
[ɔ]	585	1000	2895	520	1070	2670	600	1035	2415
	570	960	2890	620	1145	2650	630	1040	2440
	590	1010	2900	640	1080	2635	615	1025	2290
[u]	330	805	2605	395	750	2635	360	765	2760
	325	760	2545	345	770	2620	380	865	2840
	305	775	2525	335	870	2615	330	840	2540
[ɷ]	500	855	2870	455	930	2660	465	875	2390
	490	895	2865	470	900	2840	500	885	2450
	490	710	2870	475	930	2730	475	980	2415

The formant frequencies of [u], [ɷ], and [ɵ] are of particular interest. These vowels are the reflexes of Ancient (and Classical) Mongolian *y*, *u*, and *ө*, respectively. In descriptions of East Mongolian languages and dialects, the

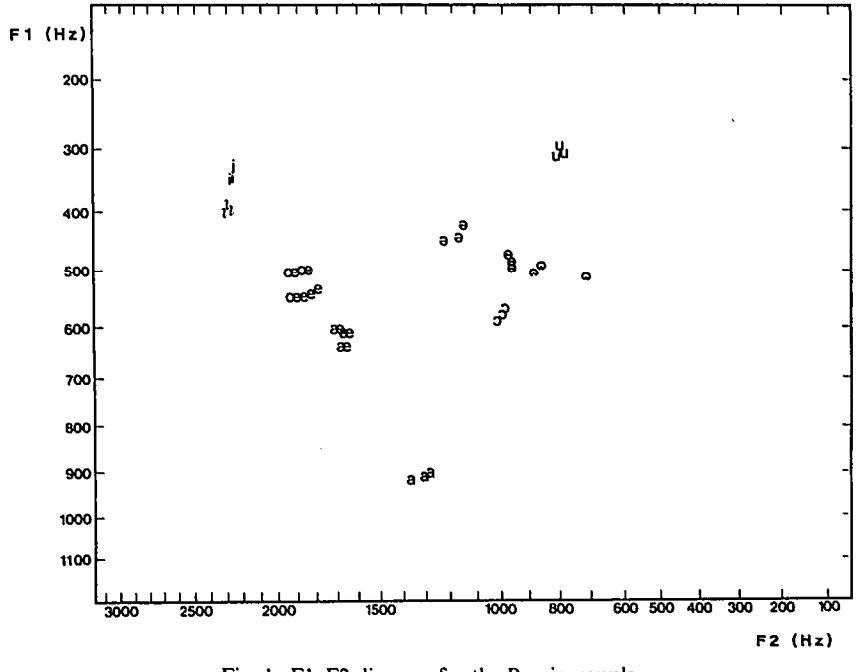

Fig. 1. F1–F2 diagram for the Baarin vowels.

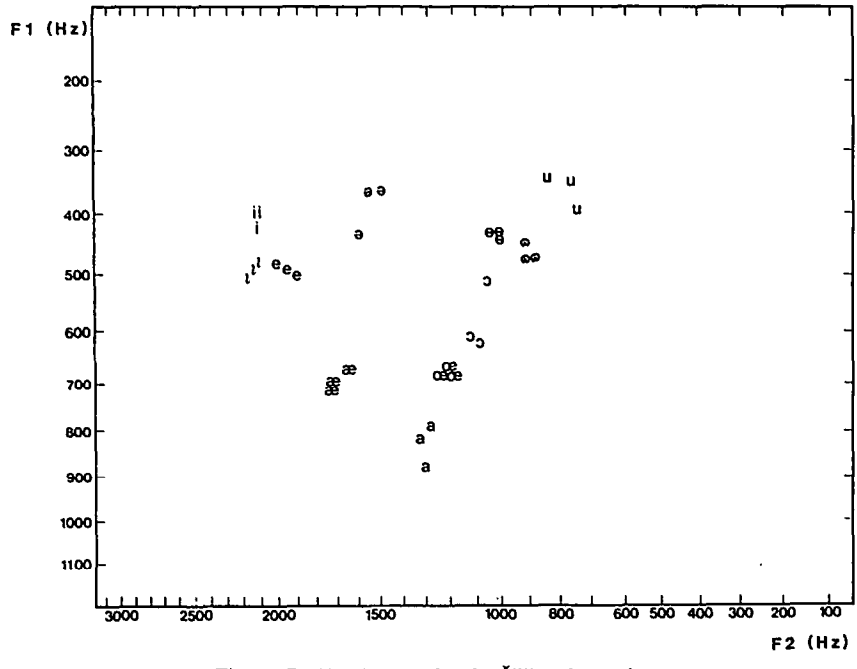

Fig. 2. F1–F2 diagram for the Šiliingol vowels.

vowel here written as [ɷ] is usually described as a vowel between [u] and [o], and [u] and [ɵ] are labeled central (or, using the terminology of Sweet (1877), 'mixed') vowels, often written as *ü* and *ö*. The Khalkha vowels were described in approximately this way by Ramstedt (1903), and other mongolists have generally followed him (among these are Činggeltei (1961), who describes Baarin, and Kara (1962), who describes the Šiliingol dialect).

The data given here show that this description of [ɷ] is correct, while [u] and [ɵ] are acoustically back vowels, although the second formant of [ɵ] is somewhat higher than its usual value for [o] (Dobu (1983) writes *o* for the vowel written as *ɵ* here).

These vowel qualities are also confirmed by the X-ray photos of Buriat vowels published by Buraev (1959). In particular, the vowel corresponding to Classical Mongolian *y* (written ү in the Cyrillic script), is clearly of the [u] type (see pictures 108–111), although it is described as a central vowel by Buraev.

Another often repeated statement from Ramstedt (1903) is that Mongolian [u] (from Classical *y*) is pronounced as Norwegian [ʉ] (written *u*, as in *hus* 'house'), but my data show that there is a large acoustical difference between

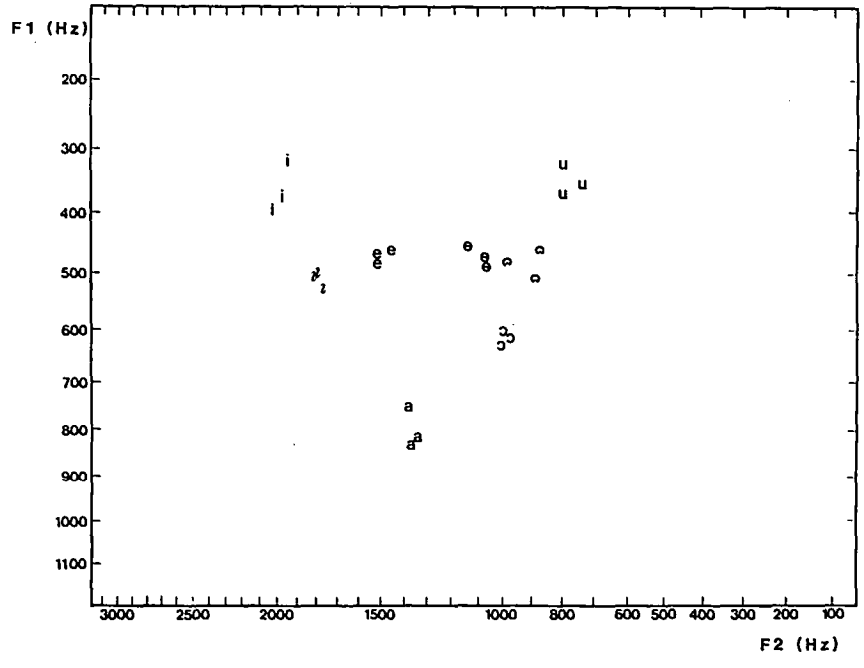

Fig. 3. F1–F2 diagram for the Khalkha vowels.

Mongolian [u] and Norwegian (or Swedish) [ʉ]; in particular, the second formant frequency of Mongolian [u] is 750–850 Hz, while that of Norwegian and Swedish [ʉ] is around 1600–1800 Hz (see e.g. Disner (1983:48–49)). On this point, Jōo's (1973, 1975) data on Khalkha and Čahar differ somewhat from mine; he found F2 values between 900 and 1100 Hz for [u] ('[ü]').

As mentioned above, linguists using modern Mongolian vowel harmony data for various phonological purposes have usually assumed that the vowels have the same qualities as in Classical Mongolian, i.e. that the vowels which are given as [u], [ɵ], and [ɷ] here are pronounced as [y], [ø], and [u], respectively.

3.3. Interpretation of vowel harmony classes

As mentioned above, Činggeltei and other Inner Mongolian scholars analyze Inner Mongolian vowel harmony as tense/lax harmony, where tense vowels are characterized by, among other things, a tensed pharynx and a retracted tongue root. By comparison of the acoustic data presented here with

acoustic data from languages which are known to have vowel harmony of this type I will show that this analysis is correct. Since the overall size of the pharynx cavity is probably the most important phonetic correlate (cf. Lindau (1979)), I will use the term pharyngeal rather than tense/lax harmony.

Comparison of the vowel harmony pairs [i] – [ɪ], [e] – [æ], [ə]/[e] – [a], [ɵ] – [ɔ], and [u] – [ʊ] in table 2 and on figures 1–3 shows the following general pattern: the frequency of the first (and often the third) formant is higher for the second member of a pair than for the first, while the second formant frequency is somewhat lower for front vowels and higher for back vowels (or roughly the same). The difference is most consistent for F1, where it is statistically significant for all vowel pairs (see table 3).

Table 3
Test of significance for the difference between formant frequencies for each vowel pair.[1]

		Baarin	Šiliingol	Khalkha	Solon
[ɪ]–[i]	F1	5.06[c]	6.35[c]	5.55[c]	20.42[d]
	F2	0.15[a]	0.40[a]	−4.24[b]	−4.22[b]
	F3	0.73[a]	−2.04[a]	−2.85[b]	−12.00[d]
[æ]–[e]	F1	6.33[c]	22.27[d]		8.54[c]
	F2	−10.00[d]	−4.80[c]		−8.04[c]
	F3	2.30[a]	3.35[b]		−6.85[c]
[a]–[ə]	F1	34.42[d]	11.86[d]	13.50[d]	14.44[d]
([e])	F2	3.94[b]	−6.66[c]	−2.78[b]	23.62[d]
	F3	7.07[c]	−4.27[b]	10.83[d]	2.57[a]
[ɔ]–[ɵ]	F1	7.99[c]	3.96[b]	8.85[d]	6.34[c]
	F2	1.71[a]	2.22[a]	−2.72[a]	13.11[d]
	F3	40.16[d]	0.98[a]	5.42[c]	−0.23[a]
[ʊ]–[u]	F1	20.80[d]	5.55[c]	6.90[c]	12.97[d]
	F2	0.69[a]	3.21[b]	2.00[a]	3.35[b]
	F3	12.87[d]	2.28[a]	−3.23[b]	0.03

[1] A two-sample t-test with 4 degrees of freedom was used. The test quantity (negative if the non-pharyngeal vowel of the pair has the larger average value) is given, and the p-value is indicated in the following way:

[a] not significant, i.e. $p > 0.05$
[b] $0.01 < p < 0.05$
[c] $0.001 < p < 0.01$
[d] $p < 0.001$

These acoustic differences are similar to those between the harmony classes in several African (Niger-Kordofanian) vowel harmony languages.

In these languages, there are nine or ten vowels, and two harmony classes, as in Akan (Lindau (1979)):

(1) i e o u
(2) ɪ ɛ ɔ ʊ

The vowel *a* is neutral.

Cineradiographic investigations of African vowel harmony languages have shown that this acoustic effect is usually produced by changing the size of the pharynx in these languages, so that the vowels of the first series are produced with a larger pharynx cavity than the vowels of the second series are (Lindau (1975, 1979), Jacobson (1980)). Halle and Stevens (1969) predict theoretically that enlarging the pharynx results in a decrease of F1, while F2 is decreased for back vowels but increased for front vowels, i.e. exactly the effect found here.

It is also striking that the terms used by Mongolian scholars for the two harmony classes ('lax' and 'tense'; 'hollow' and 'firm') are similar to terms which have been used for describing African vowel harmony classes (see Jacobson (1980)).

Comparison can also be made with the Tungusic languages, which form a separate branch of Altaic, and thus are related to Mongolian. As Ard (1981, 1984) has pointed out, many of these languages have a type of vowel harmony which is acoustically similar to that found in African languages, i.e. most probably pharyngeal harmony, and this kind of vowel harmony must be reconstructed for Proto-Tungusic.

For example, the Tungusic language Solon (Ewenki), spoken in Inner Mongolia has the following vowel harmony classes (Hú (1984)) (the vowels given here as *ɵ* and *æ*, are written as *o* and *ɛ* by Hú):

(1) i e ə ɵ u
(2) ɪ æ a ɔ ʊ

Acoustic data from a Solon speaker (from Yàohé Commune in Ewenki Autonomous County, Inner Mongolia) recorded by me in 1984 show a similar pattern as the Mongolian (and the Akan) vowels. See table 4 and figure 4.

Novikova (1960) has made X-ray studies of Even (Lamut), a language which is closely related to Solon, and has the same vowel and vowel harmony systems. She describes the vowels of the second harmony class as pharyngealized, characterized by retraction of the tongue root and contraction of the

pharynx muscles (p. 40). This can also be seen on the X-ray pictures published in her book, where it is most clearly seen for [ɪ] and [ɷ] in comparison to [i] and [u]. Buraev (1959) uses the same terms ('soft' and 'hard') for Buriat harmony classes as Novikova does for Even.

Table 4
Formant frequencies of Solon vowels.

Vowel	F1	F2	F3	Word	
[i]	345	2425	3250	i:xə:	'pot'
	335	2320	3270		
	355	2370	3245		
[ɪ]	500	2135	2915	ɪ:lda	'soot'
	485	2215	2960		
	495	2050	2865		
[e]	375	2345	3070	dət:ule:	'wing'
	400	2345	3080		
	420	2280	3120		
[æ]	510	2070	2880	bæ:ga	'moon'
	520	2060	2930		
	530	2125	2840		
[ə]	495	1155	2540	i:xə:	'pot'
	500	1120	2435		
	530	1140	2460		
[a]	670	1440	2615	a:xɪŋ	'liver'
	680	1465	2550		
	670	1440	2560		
[ɵ]	510	925	2500	xɵ:mɵ	'rice'
	500	955	2345		
	495	955	2310		
[ɔ]	585	1100	2370	ɔ:šɪt:a	'star'
	615	1105	2360		
	645	1125	2385		
[u]	355	825	2515	bu:sə:	'gave'
	385	730	2465		
	355	770	2340		
[ɷ]	500	855	2495	ɷ:gɷŋ	'saw (n.)'
	505	890	2405		
	495	875	2425		

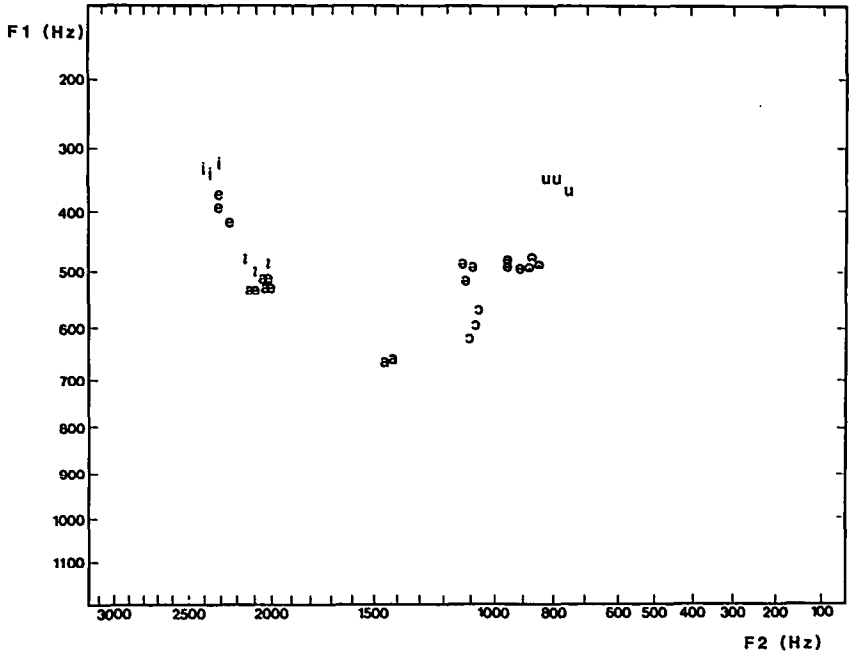

Fig. 4. F1–F2 diagram for the Solon vowels.

Consequently, an acoustic effect similar to that in East Mongolian is produced by varying the pharynx size both in several African vowel harmony languages and in the Tungusic languages, which are related to and spoken in the same area as Mongolian.

Thus it is very probable that also East Mongolian vowel harmony is based on pharynx size, and not on palatality as has usually been assumed. Unfortunately this cannot be verified by Buraev's (1959) X-ray study of Buriat, since his pictures show only a small part of the pharynx.

Also Korean, regarded to be related to Altaic by many investigators, has had a vowel harmony system of a similar kind (Ramstedt (1939), Chang (1982)).

So it seems that the Altaic languages can be divided into an eastern group with pharyngeal harmony, and a western group with palatal harmony. The western group consists of Turkic and West Mongolian, and the eastern group is Tungusic, Korean and East Mongolian.

Some languages of the Chukchi-Kamchatkan family in Eastern Siberia probably have pharyngeal vowel harmony, so it can be regarded to be an areal

feature in northern East Asia. Among African languages too, pharyngeal harmony is an areal feature.

4. Vowel harmony

In this section, the vowel systems of Classical Mongolian, Inner Mongolian (Šuluun Höh), Khalkha, and Kalmyk are given, and vowel harmony is described and analyzed in generative phonological terms. Rounding harmony will be treated in section 6.

In the modern languages, the vowels can be either short or long, and this was probably also the case in the Classical language (but since length is not indicated in the writing system, it will not be shown in examples given here). In the Cyrillic scripts for Khalkha, Buriat and Kalmyk, long vowels are doubled. Short vowels in non-first syllables are strongly reduced, and can be analyzed as shwa, as is done by Poppe (1970). In the Khalkha (and Buriat) Cyrillic scripts, they are written in the same way as unreduced vowels, but in Kalmyk they are not written at all, and single letters denote long vowels in non-first syllables (see Street (1962) for shwa in Kalmyk). There are also nasalized vowels (at least in Khalkha and Inner Mongolian), which can be analyzed as vowels followed by /ŋ/. Since length and nasalization have no direct consequence for vowel harmony, except that shwa has to be regarded as a neutral vowel, they will not be taken up here any more.

4.1. Distinctive features

As far as I know the only distinctive feature analyses of East Mongolian which take the phonetic reality into account are those of Jōo (1976) and Dobu (1984). Both use the feature system of Chomsky and Halle (1968) each with an additional, seemingly *ad hoc*, feature ('central' and 'front', respectively). Dobu distinguishes the harmony classes by the feature 'tense/lax', while the features are not related to the harmony classes in any simple way in Jōo's system.

Several different features have been proposed to account for African vowel harmony, which, as shown in the preceding section, is similar to the Mongolian one. Chomsky and Halle (1968) tentatively suggest a feature 'covered', but Halle and Stevens (1969) replace this with 'advanced tongue root' (following a suggestion of Stewart (1967)). Lindau (1975, 1979) uses the feature 'expanded'.

These features might be used to describe East Mongolian vowel harmony as well. But vowel harmony in Ancient and Classical Mongolian was based on

the feature 'back' (in the Chomsky-Halle feature system), which has no special relation to the features mentioned. So if the Mongolian vowel harmony shift is described in terms of Chomsky and Halle's distinctive features, it is necessary to introduce an additional feature, unrelated to those used for the ancestor language, to account for East Mongolian vowel harmony.

For this and other reasons (cf. Wood (1975a)), I have chosen to use the articulatory vowel features proposed by Wood (1975b, 1979) instead. He uses three features which are directly related to activity in different muscle groups:

Feature	Muscles involved
palatal	genioglossi
velar	styloglossi
pharyngeal	hyoglossi, pharyngeal constrictors

Using these features, the four main places of articulation (areas of narrowest constriction) for vowels can be defined:

[+pal, −vel, −phar]: hard palate ([i], [e], etc.)
[+pal, +vel, −phar]: soft palate ([u], [ɨ], etc.)
[−pal, +vel, +phar]: upper pharynx ([o], [ɔ], etc.)
[−pal, −vel, +phar]: lower pharynx ([a], etc.)

The front vowels are thus defined by the features [+pal, −vel], which corresponds to the articulatory definition that the main activity is in the genioglossi muscles. This muscle pushes the tongue body forward towards the hard palate, and at the same time the tongue root is pulled forward, widening the pharynx (Wood (1979: 35–37)). Normally, the features 'palatal' and 'pharyngeal' have opposite values, and this is also the case in Classical Mongolian. In this way, Wood's vowel feature system captures the natural connection between front articulation and relatively wide pharynx, a connection which is not captured by the feature system of Chomsky and Halle. The pharynx may be contracted, however, more or less independently of this muscle action, using the pharynx constrictors, and it seems probable that this mechanism is used in East Mongolian vowel harmony.

The feature 'open' will also be used. It is defined (Wood (1975b)) by referring to the degree of jaw-opening.

4.2. Pharyngeal harmony in East Mongolian

East Mongolian will be represented by Inner Mongolian and Khalkha. For Inner Mongolian I will use the Šuluun Höh dialect, since a large amount of data is available in Dobu (1983), but other Čahar, Baarin, and Horčin dialects probably do not differ substantially from this (cf. the acoustic data in the preceding section, and also Bosson and Unensečen's (1962a) description of Horčin).

Khalkha data are taken from the standard literary language in the Mongolian People's Republic, written with a Cyrillic-based script. I have used standard grammars and textbooks, such as Poppe (1951) and Bosson (1964), and all forms cited have been checked with the official orthographic dictionary of Damdinsüren and Osor (1983). The vowel systems are as follows:

Šuluun Höh				*Khalkha*		
i			u	i		u
ɪ			ʊ			ʊ
e	ø	ə	ɵ	e		ɵ
æ	œ	a	ɔ		a	ɔ

Harmony classes

	Šuluun Höh						*Khalkha*		
non-pharyngeal:	i	e	ø	ə	ɵ	u	e	ɵ	u
pharyngeal:	ɪ	æ	œ	a	ɔ	ʊ	a	ɔ	ʊ
neutral:	–						i		

The Khalkha vowels are usually written and transcribed in the following way:

Vowel	Cyrillic letter	Usual transcription
/i/	и	*i*
/e/	э	*e*
/u/	ү	*ü*
/ʊ/	у	*u*
/ɵ/	ө	*ö*
/ɔ/	о	*o*
/a/	а	*a*

The Khalkha system differs from that of Šuluun Höh by the absence of open front vowels (except /e/, which corresponds to Šuluun Höh /ə/).

The Cyrillic Khalkha spelling differentiates between ы and ий, presumably corresponding to [ɪ:] and [i:], respectively. ы is found only in pharyngeal words, but ий may occur both in pharyngeal and non-pharyngeal words. The problem of the phonemic status of Khalkha [ɪ:] deserves further study (Street (1973) analyzes written ы as /əi/); here I will assume that [ɪ:] is an allophone of /i:/.

The East Mongolian vowels can be given the following feature specifications:

Šuluun Höh	i	ɪ	u	ʊ	ə	a	e	æ	ɵ	ɔ	ø	œ
open	−	−	−	−	+	+	+	+	+	+	+	+
round	−	−	+	+	−	−	−	−	+	+	+	+
palatal	+	+	+	+	−	−	+	+	−	−	+	+
pharyngeal	−	+	−	+	−	+	−	+	−	+	−	+
velar	−	−	+	+	+	−	−	−	+	+	−	−

Khalkha	i	u	ʊ	e	a	ɵ	ɔ
open	−	−	−	+	+	+	+
round	−	+	+	−	−	+	+
pharyngeal	−	−	+	−	+	−	+
palatal	+	+	+	+	−	−	−
velar	−	+	+	−	−	+	+

The feature 'velar' in Šuluun Höh, and the features 'velar' and 'palatal' in Khalkha are redundant, and can be predicted from the values of the other features.

The vowel harmony rule says that all vowels of a word must have the same value for the feature 'pharyngeal', except that the neutral, non-pharyngeal vowel *i* may occur in non-first syllables both in pharyngeal and non-pharyngeal words in Khalkha. If the first vowel of a word is *i*, the word is non-pharyngeal, however. So both in Khalkha and in Šuluun Höh the harmony class of a word can be determined from its first vowel.

Pharyngeal harmony works in the same way both in roots and in suffixes, and causes suffix vowels (except Khalkha *i*) to have two or, due to rounding harmony, four alternating forms. Some examples are:

	Šuluun Höh	*Khalkha*	
Collective numerals	gɷrb-ɷ:l	gɷrv-ɷ:l	'three'
	arb-ɷ:l	arv-ɷ:l	'ten'
	dərb-u:l	dərv-u:l	'four'
	jis-u:l	jəs-u:l	'nine'
Instrumental	ača:-ga:r	ača:-ga:r	'burden'
	tɷ:læ:-ga:r	tɷ:lai-ga:r	'hare'
	gu̯jə:-gə:r	guze:-ge:r	'rumen'
	də:l-ə:r	de:l-e:r	'coat'
	nɔxœ:-gɔ:r	nɔxɔi-gɔ:r	'dog'
	dərə:-gə:r	dərə:-gə:r	'stirrup'
Narrative past	jab-la:	jav-la:	'go'
	u̯j-lə:	uz-le:	'see'
	ɔr-lɔ:	ɔr-lɔ:	'enter'
	əg-lə:	əg-lə:	'give'
Neutral *i* in Khalkha			
Instrumental	æ̆jıl-a:r	a̋jil-a:r	'work'
	mœrj-ɔ:r	mɔri-ɔ:r	'horse'
	ǰečgə:-gə:r	cəcgi:-gə:r	'cream'
Accusative	gar-ı:g	gar-i:g	'hand'
	gər-i:g	ger-i:g	'house'
i in t^h · first syllable in Khalkha			
	bilu:d-lə:	bilu:d-le:	'whetted'
	širə:-gə:r	šire:-ge:r	'table (instr.)'
	id-lə:	id-le:	'ate'
	bičig-ə:r	bičig-e:r	'letter (instr.)'
Cf.:			
	ılg-la:	jalg-la:	'distinguished'
	ıla:-ga:r	jala:-ga:r	'fly (instr.)'

Thus it can be assumed that only the first vowel is specified for the feature 'pharyngeal'. Following Steriade (1981), I will also assume that vowel har-

mony rules only fill in unspecified feature values, and do not change those which are already specified.

The vowel harmony rule can be written as a progressive assimilation rule which is applied to each vowel in turn from left to right:

$$(1)\quad [+\text{syll}] \rightarrow [\alpha\text{phar}] \,/ \begin{bmatrix} +\text{syll} \\ \alpha\text{phar} \end{bmatrix} C_0 \text{——}$$

When rule (1) is applied in Khalkha, it gives [ɪ] with the feature value [+phar] in pharyngeal words, such as /gari:g/, and this must be adjusted by a rule:

$$(2)\quad \begin{bmatrix} +\text{syll} \\ -\text{open} \\ -\text{round} \end{bmatrix} \rightarrow [-\text{phar}]$$

4.3. Palatal harmony in Classical and West Mongolian

In Classical Mongolian, vowel harmony was based on palatality (frontness), and this kind of vowel harmony is still found in West Mongolian (Oirat).

For West Mongolian, examples will be taken from literary Kalmyk, the Cyrillic-based written language used by the Kalmyks in the Soviet Union. My sources are Todaeva (1968) and the dictionary of Iliškin (1964). Street (1962) gives the same vowel system as Todaeva does. Other sources, such as Ramstedt (1935) and Jiă (1982) describe dialects which differ somewhat from this, but the differences concern only details as regards vowel harmony. The vowel systems are as follows:

Classical			*Kalmyk*		
i	y	u	i	y	u
e	ø	o	e	ø	o
	a		æ	a	

Harmony classes

	Classical			*Kalmyk*			
palatal:	e	y	ø	e	æ	y	ø
non-palatal:	a	u	o		a	u	o
neutral:	i			i			

The Kalmyk vowels are written in the following way in the Cyrillic alphabet (note that the letters do not always have the same pronunciation as in Khalkha):

Vowel	Cyrillic letter
/i/	и
/e/	е, э
/æ/	ə
/y/	ү
/ø/	ө
/u/	у
/o/	о
/a/	а

The vowels can be given these feature specifications:

Classical	i	y	u	a	e	o	ø
open	−	−	−	+	+	+	+
round	−	+	+	−	−	+	+
palatal	+	+	+	−	+	−	+
velar	−	−	+	−	−	+	−
pharyngeal	−	−	−	+	−	+	−

Kalmyk	i	y	u	a	e	æ	o	ø
open	−	−	−	+	+	+	+	+
round	−	+	+	−	−	−	+	+
palatal	+	+	+	−	+	+	−	+
velar	−	−	+	−	−	−	+	−
pharyngeal	−	−	−	+	−	+	+	−

The feature 'pharyngeal' is redundant in Classical Mongolian, having the opposite value of 'palatal' (it is of course also possible to regard 'palatal' as the redundant feature). It may also be noted that the feature 'velar' is necessary to distinguish between the two vowels /u/ and /y/, but it is otherwise not distinctive.

Here vowel harmony requires that either all the vowels in a word must be front or all (except neutral *i*) must be back (non-front). Suffix vowels have only two alternating forms, since there is no rounding harmony (and *i* remains unchanged).

In Kalmyk, the first vowel of a word determines its harmony class, and as in Khalkha this is true also for neutral *i*, so that words which have *i* as their first vowel are front harmonic.

In Classical Mongolian, however, *i* may occur in initial position both in front and back harmonic words, and the first non-neutral vowel determines vowel harmony. If all vowels of a root are neutral, suffix vowels are front.

Examples (here and elsewhere, the gloss gives the meaning of the root; verbs are given in the imperative, which is identical to the root):

	Classical	*Kalmyk*	
Causative verbs	jabu-γul	jov-u:l	'go'
	oro-γul	or-u:l	'enter'
	yǰe-gyl	yz-y:l	'see'
	mede-gyl	med-y:l	'know'
	oirata-γul	ø:rd-y:l	'approach'
Ablative	ulus-ača	uls-a:s	'nation'
	aman-ača	amn-a:s	'mouth'
	yker-eče	ykr-æ:s	'ox'
	møren-eče	mørn-æ:s	'river'
	morin-ača	mørn-æ:s	'horse'
Neutral *i*			
Accusative	γal-i	hal-i:g	'fire'
	baγatur-i	ba:tr-i:g	'hero'
	keyken-i	ky:kn-i:g	'girl'
	nidy-ji	nyd-i:g	'eye'
Initial *i*			
Narrative past	jirga-luγa	jirh-læ:	'live happily'
	ire-lyge	ir-læ:	'come'
	biči-lyge	bič-læ:	'write'
Ablative	ilγaγa-ača	jilhæ:n-æ:s	'difference'
	ǰidan-ača	ǰidn-æ:s	'spear'
	imaγan-ača	jama:n-a:s	'goat'
	ičegyri-eče	ičr-æ:s	'shame'
	bičig-eče	bičg-æ:s	'letter'
	ǰil-eče	ǰil-æ:s	'year'

As seen from these examples, some words have changed their harmony class in Kalmyk (and in Oirat in general). This has taken place when initial *i* in Classical Mongolian back harmonic words has remained unchanged (as in the examples 'live happily', 'difference', and 'spear'), and also when the first vowel of a (back harmonic) word has been umlauted (as in 'approach' and 'horse'). In both these cases, back harmonic words in Classical Mongolian have become front harmonic in Kalmyk. Apparently, not all Oirat dialects are equal in this respect. Thus, according to Jiă (1982), initial *i* has not caused fronting in the dialect spoken in Western Qīnghăi; cf. also Binnick (1969).

In some Classical Mongolian back harmonic words with *i* as their first vowel, *i* has been assimilated to the following vowel in Kalmyk and other modern languages (by 'breaking', see section 5.3), and the word has remained back harmonic (as in the example 'goat').

Note that vowel harmony as such is preserved both in West and East Mongolian, but that this has been attained in different ways. In West Mongolian, the phonetic basis of vowel harmony remains unchanged, while many words have changed their vowel harmony class. In East Mongolian, the phonetic basis has changed, but virtually all individual words have retained their vowel harmony class, so that those and only those words which were back harmonic in Classical Mongolian are pharyngeal in East Mongolian.

In the features used, front vowels are characterized as [+pal, −vel], and the back (non-front) vowels do not form a very natural class (it must be characterized by a disjunction {[−pal],[+vel]}). Thus the harmony rule in Classical Mongolian and Oirat must be asymmetric, giving the marked values [+pal, −vel] to vowels in front harmonic words, and vowels in back harmonic words have unmarked values for these features, given by a redundancy rule.

It can be assumed that only the harmony determining vowel, i.e. the first vowel in Kalmyk and the first non-neutral vowel in Classical Mongolian (or the first vowel if all are neutral) is specified for the features 'palatal' and 'velar' (and, redundantly, for 'pharyngeal').

The following assimilation rule takes care of vowel harmony in front harmonic words:

$$(3)\quad [+\text{syll}] \rightarrow \begin{bmatrix} +\text{pal} \\ -\text{vel} \end{bmatrix} \Big/ \begin{bmatrix} +\text{syll} \\ +\text{pal} \\ -\text{vel} \end{bmatrix} C_0 \_\_$$

This rule is applied recursively from left to right, as the corresponding rule (1) in East Mongolian.

For those vowels which occur in back-vocalic words, and for initial neutral *i* in Classical Mongolian, the two remaining features 'open' and 'round' determine the values of the features 'palatal' and 'velar':

	u	o	a	i
open	−	+	+	−
round	+	+	−	−
palatal	+	−	−	+
velar	+	+	−	−

Thus, 'palatal' has the opposite value of 'open', and 'velar' has the same value as 'round', so the unmarked values of these features are given by the redundancy rule:

$$(4)\ \begin{bmatrix} +\text{syll} \\ \alpha\text{open} \\ \beta\text{round} \end{bmatrix} \rightarrow \begin{bmatrix} -\alpha\text{pal} \\ \beta\text{vel} \end{bmatrix}$$

It should be noted that neutral *i* gets its correct specification both in back and front harmonic words by these rules.

Since the feature 'pharyngeal' has different values for [o] and [ø], the following rule must be applied after the vowel harmony rules (3) and (4) in Kalmyk:

$$(5)\ \begin{bmatrix} +\text{syll} \\ +\text{round} \\ +\text{pal} \end{bmatrix} \rightarrow [-\text{phar}]$$

This rule also accounts for the merger of umlauted *o* with original *ø* in Kalmyk (see section 5.1). In Classical Mongolian, this rule is not necessary, since the feature 'pharyngeal' is redundant, having the opposite value of 'palatal'. It should be noted that this redundancy also explains why *a* alternates with *e* in Khalkha, while in Kalmyk, where the feature 'pharyngeal' is not redundant, *a* alternates with *æ*.

The neutral *i* in initial position is no doubt a problem and a complication in Classical Mongolian vowel harmony. Ancient Mongolian probably had a back vowel **i*, corresponding to Classical Mongolian *i* in back harmonic words. So both in Ancient Mongolian and in many of the modern languages it is

possible to determine the harmony class of a word from its first vowel. In Buriat (Poppe (1960a), Bosson (1962b)), and apparently in the Ordos Inner Mongolian dialect (Mostaert (1926–1927), Qaserdeni (1981)) *i* is still neutral in all positions of a word, as it was in Classical Mongolian.

4.4. Exceptions

Exceptions from vowel harmony (and rounding harmony) in Mongolian are of three kinds: compound words with constituents from different harmony classes, foreign loans, which mix vowels from both classes, and words which contain unchangeable suffixes.

Many of the compounds are placenames (e.g. (in Khalkha form) *xөxxɔt*, from *xөx* 'blue' and *xɔt* 'city') or names of persons (e.g. *ɷlã:xu:*, from *ɷlã:* 'red' and *xu:* 'boy'), but other words also occur, e.g. *gazarzui* 'geography' (from *gazar* 'place' and *zui* 'principle'). These words always take suffixes with vowels from the harmony class of the last component (so that e.g. the instrumental of the words mentioned are *xөxxɔt-ɔ:r*, *ɷlã:xu:-ge:r*, and *gazarzui-ge:r*), so from the point of view of vowel harmony they can be regarded as two words, even though they are usually written as one word both in the traditional and the Cyrillic orthography. Their intonation, with a strong secondary accent on the second component also shows that they may be regarded as two words.

Many recent loans, especially Russian words, which are introduced into Khalkha in their Russian orthographic form, violate the vowel harmony rules. Suffixes often follow the harmony class of the vowel which is stressed in Russian. Examples from Khalkha:

ekrán-a:s	'film screen (abl.)'
Gerásim-tai	'Gerasim (comit.)'
ɔficér-u:d	'officer (plur.)'

If the stressed vowel is *i*, and if the word contains Russian back vowels, suffix vowels are usually pharyngeal, however:

Mítja-ga:r	'Mitja (instr.)'
kapitalíst-ɷ:d	'capitalist (plur.)'
mašín-a:r	'car (instr.)'
bɔl'ševík-ɷ:d	'bolshevik (plur.)'

But:

men'ševík-u:d 'menshevik (plur.)'

There are also many words which are given unrounded suffixes although the stressed syllable is ɔ:

avtɔ́bus-na:s 'bus (abl.)'
subbɔ́tnik-tai 'subbotnik (comit.)'
Kɔ́lja-tai 'Kolja (comit.)'

But cf.:

kɔridɔ́:r-ɔ:r 'corridor (instr.)'
Pánɔv-ɔ:s 'Panov (abl.)'
mɔtɔcíkl-tɔi 'motorcycle (comit.)'

There are many irregularities and inconsistencies in the treatment of loans, and a general rule which covers all cases is impossible to give. For instance, besides the form *mɔtɔcíkl-tɔi* cited above, *mɔtɔcíkl-tei* has also been noted (in fact, the two forms were found on the same page in an elementary school textbook).

Such loans must be treated as exceptions and marked as such in the lexicon, but it is probably possible to cover most cases by special rules which apply to loans (cf. Steriade (1981)).

Yamada (1983) proposes to account for both compounds and loans which violate vowel harmony by introducing abstract underlying vowels. This is perhaps possible for those few examples he gives, but not for words which contain vowels differing only in the harmonizing feature (given as 'back'), such as *ɔlã:xu:*.

There are also a few suffixes, which are unchanged, regardless of the harmony class of the word they are affixed to. They include (in Khalkha) the narrative past suffix *je: / če:* and the negative *gui*.

The irregular suffixes are different in different dialects: in Šuluun Höh, the negative suffix has two alternating forms (given as *gɔe / gue* by Dobu (1983)), while the ordinal number suffix, which alternates in Khalkha (*dɔga:r / duge:r*), has only one form, *dɔga:r*. Examples are:

	Khalkha	*Šuluun Höh*	
Narrative past	med-ǰe:	məd-ǰe:	'know'
	xi:-je:	xi:-je:	'do'
	gar-če:	gar-ǰe:	'go out'
	sɔns-je:	sɔns-ǰe:	'hear'
Negated imperfect	med-e:-gui	məd-ə:-gue	'know'
	sɑr-a:-gui	sɑr-a:-gɑe	'study'
Instrumental	med-e:-gui-ge:r	məd-ə:-gue-gə:r	
	sɑr-a:-gui-ge:r	sɑr-a:-gɑe-ga:r	
Ordinal numbers	tav-dɑga:r	tab-dɑga:r	'fifth'
	neg-duge:r	nəg-dɑga:r	'first'

The negative and ordinal suffixes can take further suffixes, which then follow their vowel harmony class (see the examples with negative forms in the instrumental). There are free forms *ugui* (Šuluun Höh *ugue*) and *dɑga:r* 'sequence', corresponding to these suffixes.

One possible way to account for the unchangeable suffixes is to introduce a boundary before them, although (except perhaps in the case of *dɑga:r*) this boundary is not signalled by intonation as in the case of compound words.

Another way of treating them, based on the (debatable) fact that all unchangeable suffixes in Khalkha are non-pharyngeal ('front') has been proposed by Odden (1977). This seems to be a mere coincidence, however, since there are similar pharyngeal suffixes in Šuluun Höh and in other dialects.

5. Vowel shift and vowel harmony shift

Two phonological processes, backing of front vowels and umlaut have affected the vowel systems of virtually all modern Mongolian dialects.

In this section, these vowel shifts, which have led to the restructuring of the vowel and the vowel harmony systems of both East and West Mongolian will be described, and rules for the vowel changes from Classical Mongolian to modern languages are given. These vowel changes are well-known from the literature (some are described already by Ramstedt (1903)), and I have used Poppe (1955,1960b) and, for dialects spoken in China, Činggeltei (1979) and Dobu (1983), as my main sources.

5.1. Umlaut

Umlaut due to a following *i* has taken place in most Inner Mongolian dialects, in some varieties of Khalkha and Buriat, and also in Oirat.

Usually the back vowels *a* and *o* have been umlauted into [æ] and [œ], respectively. In some dialects, *u* has also been affected. The conditioning *i* can appear either immediately after the vowel, in which case the result is that the diphthong has become a long vowel (*ai* > [æ:], *oi* > [œ:]), or after an intervening consonant. The Classical Mongolian groups *aji* and *oji* have developed in the same way as *ai* and *oi*. The phonemic status of umlauted vowels is different in different dialects. In some dialects (e.g. that described in the Inner Mongolian orthoepic dictionary by Bürintegüs (1977)), the conditioning *i* has disappeared, so that umlauted and non-umlauted vowels contrast (e.g. *æm* 'life' (from *ami*) and *am* 'mouth' (from *ama*)). The long umlauted vowels (from *diphthongs) contrast with the corresponding non-umlauted vowels in all dialects where they occur.

In Standard Khalkha, umlaut has not led to restructuring of the phoneme system, and short umlauted vowels are allophones of the corresponding non-umlauted vowel phoneme, while the diphthongs have been retained as such.

In Oirat (see Činggeltei (1979), and Todaeva (1968) for Kalmyk), umlauted *u* and *o* have merged with original *y* and *ø*, which have not been backed in this language. Examples:

Classical	*Šuluun Höh*	*Khalkha*	*Kalmyk*	
ami	æmj	ami	æmn	'life'
bajiqu	bæ:x	baix	bæ:x	'to be'
qoni	xœnj	xɔni	xøn	'sheep'
ojimasu	œ:ms	ɔims	ø:msn	'stocking'
qubi	xɷbj [xʏbj]	xɷvi	xyv	'part'

Cf.:

ama	am	am	amn	'mouth'
olusu	ɷls	ɷls	olsn	'hemp'
ulaγan	ɷlɑ̃:	ɷlɑ̃:	ula:n	'red'
ger	gər	ger	ger	'house'
møren	mərɵ̃	mərɵ̃	mørn	'river'
yne	un	un	yn	'price'

The umlaut rule can be formulated in the following way:

$$(6)\quad \begin{bmatrix} +\text{syll} \\ +\text{phar} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{pal} \\ -\text{vel} \end{bmatrix} / \text{——}C_0 \begin{bmatrix} +\text{syll} \\ +\text{pal} \\ -\text{vel} \\ -\text{open} \\ -\text{round} \end{bmatrix}$$

This rule umlauts *a* and *o* into [æ] and [œ], respectively. In Kalmyk, where also *u* is umlauted (into [y]), it must be formulated in a more complicated way, as:

$$(6')\quad \begin{bmatrix} +\text{syll} \\ \left\{ \begin{matrix} [+\text{phar}] \\ [+\text{vel}] \end{matrix} \right\} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{pal} \\ -\text{vel} \end{bmatrix} / \text{——}C_0 \begin{bmatrix} +\text{syll} \\ +\text{pal} \\ -\text{vel} \\ -\text{open} \\ -\text{round} \end{bmatrix}$$

Furthermore, in order to merge umlauted *o* with *ø* in Kalmyk, rule (5), given already in section 4.3 is needed:

$$(5)\ \begin{bmatrix} +\text{syll} \\ +\text{round} \\ +\text{pal} \end{bmatrix} \rightarrow [-\text{phar}]$$

In Oirat, where fronting harmony is preserved, words where the first vowel has been umlauted have also changed their harmony class, a phenomenon unknown in East Mongolian. Also originally back harmonic words with initial *i* have changed harmony class in Kalmyk (except when breaking has taken place, see section 5.3). Examples:

	Classical	*Kalmyk*	*Šuluun Höh*	*Khalkha*	
Causative	ojirata-γul	ø:rd-y:l	œ:rd-ɷ:l	ɔird-ɷ:l	'approach'
	qajilu-γul	xæ:l-y:l	xæ:l-ɷ:l	xail-ɷ:l	'melt'
Ablative	morin-ača	mørn-æ:s	mœrjn-ɔ:s	mɔrin-ɔ:s	'horse'
	amin-ača	æmn-æ:s	æmjn-a:s	amin-a:s	'life'
	ǰidan-ača	ǰidn-æ:s	ǰɪdn-a:s	ǰadn-a:s	'spear'

Cf.:

	jil-eče	jil-æ:s	jil-ə:s	jil-e:s	'year'

Furthermore, the umlaut rule (6′) is blocked in subsequent syllables if the first vowel is back, so that vowel harmony is preserved also in this case. Examples from Standard Kalmyk:

	Classical	*Kalmyk*	*Šuluun Höh*	*Khalkha*	
	ɣaqai	haxa:	gaxæ:	gaxai	'pig'
	noqai	noxa:	nɔxœ:	nɔxɔi	'dog'
	toluɣai	tolha:	tɔlgœ:	tɔlgɔi	'head'
Comitative	ɣaqai-luɣa	haxa:-ta:	gaxæ:-tæ:	gaxai-tai	
	noqai-luɣa	noxa:-ta:	nɔxœ:-tæ:	nɔxɔi-tɔi	
	toluɣai-luɣa	tolha:-ta:	tɔlgœ:-tæ:	tɔlgɔi-tɔi	

These words have retained their harmony classification both in Kalmyk (back) and in East Mongolian (pharyngeal).

Apparently, this blocking applies only to the Torgut dialect of Oirat (on which the Kalmyk written language is based). In Dörbet and other dialects [a] is umlauted also in non-initial syllables in back harmonic words. The example *tanæ:* 'your' (Torgut *tana:*) is given in Todaeva (1968), who says that [æ] has become a second neutral vowel in Dörbet. Similar examples can be found in Ramstedt (1935) and Jiă (1982).

5.2. Backing

Backing of *y* and *ø* into [u] and [ɵ] has probably taken place in all East Mongolian dialects, but the original vowels are preserved in Oirat. Backing has not led to merger with *u*, which has developed into [ʊ] by pharyngealization. Examples:

Classical	*Šuluun Höh*	*Khalkha*	*Kalmyk*	
syke	sux	sux	syk	'axe'
egyde	u:d	u:d	y:dn	'door'
køke	gɵx	xɵx	køk	'blue'
bøgere	bɵ:r	bɵ:r	bø:r	'kidney'
ulus	ʊls	ʊls	uls	'nation'
aɣula	ʊ:l	ʊ:l	u:l	'mountain'

As seen from these and other examples, long vowels have developed from groups with *g* and *γ* (and also *j*). See Poppe (1955) for details of this process, which has no direct consequence for vowel harmony and will not be taken into consideration when vowel shift rules are formulated.

The pharyngealization and backing rules can be formulated in the following way:

Pharyngealization:

(7) $\begin{bmatrix} +\text{syll} \\ +\text{vel} \end{bmatrix} \rightarrow [+\text{phar}]$

Backing:

(8) $\begin{bmatrix} +\text{syll} \\ -\text{phar} \\ +\text{round} \end{bmatrix} \rightarrow [+\text{vel}]$

It can be noted that rule (7) eliminates the distinctive function of the feature 'velar' (which was necessary to distinguish [y] from [u]), and makes this feature redundant in East Mongolian. So rule (8) is not strictly necessary, as it assigns a value to a redundant feature. In Classical Mongolian, the features 'palatal' and 'pharyngeal' have opposite values for each vowel, so one of them can be regarded as redundant, but after the application of rule (7) this is no longer the case, and the feature 'pharyngeal' is chosen as the non-redundant one of these two (in Šuluun Höh, but not in Khalkha, the feature 'palatal' is also used to differentiate vowels).

In most Inner Mongolian dialects, but not in Khalkha and Oirat, [e] has become [ə]:

Classical	*Šuluun Höh*	*Khalkha*	*Kalmyk*	
ene	ən	en	en	'this'
sigesy	šə:s	še:s	še:sn	'piss'

The rule can be written as:

(9) $\begin{bmatrix} +\text{syll} \\ -\text{phar} \\ +\text{open} \end{bmatrix} \rightarrow [+\text{vel}]$

In order to give the segments [ɵ] and [ə] their correct values for the feature 'palatal', the following rule is needed:

$$(10)\begin{bmatrix} +\text{syll} \\ +\text{vel} \\ +\text{open} \end{bmatrix} \rightarrow [-\text{pal}]$$

5.3. Initial /i/

It is not always possible to determine the vowel harmony status of a Classical Mongolian word from its first vowel, since neutral *i* could occur as the first vowel both in back and front harmonic words. In many modern Mongolian languages this complication in the vowel harmony has been eliminated, but in different ways in different languages. In Khalkha, initial *i* in back harmonic words has been 'broken', i.e. assimilated to the following vowel in a rather complicated way, and in Šuluun Höh, the Classical Mongolian phoneme /i/ has split into two, /i/ and /ɪ/, found in non-pharyngeal and pharyngeal words, respectively. In Oirat, breaking has taken place in some words with original initial /i/, while others have changed their harmony class, and in this process following back vowels have been fronted (but this has not taken place in Khalkha, as asserted by Binninck (1980)). Examples:

	Classical	*Šuluun Höh*	*Khalkha*	*Kalmyk*	
Ablative	ilγaγa-ača	ɪlga:n-a:s	jalga:n-a:s	jilhæ:n-æ:s	'difference'
	ilaγan-ača	ɪla:n-a:s	jala:n-a:s	ilæ:sn-æ:s	'fly, gnat'
	kitad-ača	xɪtad-a:s	xjatad-a:s	kitd-æ:s	'China'
	ǰidan-ača	ǰɪdn-a:s	ǰadn-a:s	ǰidn-æ:s	'spear'
	imaγan-ača	jama:n-a:s	jama:n-a:s	jama:n-a:s	'goat'
	nidyn-eče	nudn-ə:s	nudn-e:s	nydn-æ:s	'eye'
	siregen-eče	širə:n-ə:s	šire:n-e:s	širæ:n-æ:s	'table'
	ǰil-eče	ǰil-ə:s	ǰil-e:s	ǰil-æ:s	'year'
	bičig-eče	bičig-ə:s	bičig-e:s	bičg-æ:s	'letter'
	čikin-eče	čixn-ə:s	čixn-e:s	čikn-æ:s	'ear'

There is even a strong tendency for foreign loanwords to be changed so that vowel harmony can be determined by the first vowel, e.g. the Russian loanword *kino* 'cinema' is /kɪnɔ:/ in Šuluun Höh and is often pronounced [xjɔnɔ:] in Khalkha (James Bosson, personal communication). (The word **jila:*

'gnat' cited by Jensen and Stong-Jensen (1979), Odden (1980), and Yamada (1983) as an example of a 'back-vocalic' Khalkha word with /i/ as its first vowel does not exist in Standard Khalkha. The correct form is *jala:* (see e.g. Damdinsüren and Osor (1983)), with breaking as expected.

As seen by comparing e.g. the examples 'goat' and 'fly' given above, breaking is not a uniform process, and Kuribayashi (1982) shows by using data from different Mongolian languages (including also Buriat and Ordos) that it has probably taken place in two steps. In those East Mongolian dialects, where only the first breaking process has been completed (e.g. Buriat and Ordos), neutral *i* may still occur in first syllables in both pharyngeal and non-pharyngeal words.

The two following examples show that /i/ and /ɪ/ are different phonemes in Šuluun Höh:

Classical	*Šuluun Höh*	*Khalkha*	
ire	ir	ir	'come'
ira	ɪr	jar	'expose'

Both /i/ and /ɪ/ correspond to Classical Mongolian neutral *i*. Ancient Mongolian probably had a phoneme */i̯/, but /ɪ/ cannot be a direct descendant of this; rather the contrast between */i/ and */i̯/ has disappeared (already in Classical Mongolian) and then partly reappeared as the contrast between /i/ and /ɪ/ in Šuluun Höh. This is proved by the fact that words which in Ancient Mongolian contained only the vowel **i̯* became front harmonic in Classical Mongolian when **i̯ > i* (Poppe (1955, 1960b)), and these words are non-pharyngeal and contain the vowel /i/ in Šuluun Höh. Examples (Ancient Mongolian vowel according to Poppe (1960b)):

	Classical	*Šuluun Höh*	
Ancient **i̯*	bi	bi:	'I'
	im	im	'earmark'
	čiči	ǰiči	'to thrust'
Ancient **i̯*	ǰil	ǰil	'year'
	čikin	čix	'ear'
	ki	xi:	'to do'

5.4. Vowel harmony shift

As mentioned above, the main reason for adopting Wood's articulatory feature system here is that the vowel harmony rules in East Mongolian and in its ancestor languages, Ancient and Classical Mongolian, are seen to be related if they are formulated within this feature system. If the Chomsky-Halle feature system is used, the vowel harmony rules are not related, being based on the features 'covered' and 'back', respectively. This is seen most clearly if the East Mongolian vowel harmony rule (3) is given the following form, which is equivalent, since the features 'palatal' and 'pharyngeal' have opposite values in Classical Mongolian:

$$(3') \quad [+\text{syll}] \rightarrow \begin{bmatrix} -\text{phar} \\ -\text{vel} \end{bmatrix} / \begin{bmatrix} +\text{syll} \\ -\text{phar} \\ -\text{vel} \end{bmatrix} C_0 \_\_$$

The East Mongolian vowel harmony rule is:

$$(1) \quad [+\text{syll}] \rightarrow [\alpha\text{phar}] / \begin{bmatrix} +\text{syll} \\ \alpha\text{phar} \end{bmatrix} C_0 \_\_$$

The [−phar] part of rule (1) is a simplification of rule (3'), apparently conditioned by the pharyngealization rule (7), which converts [u] into [ɷ], and at the same time makes the feature 'velar' redundant, so that it can be dispensed with in the vowel harmony rule. The redundancy rule (4) collapses into the [+phar] part of rule (1), so that the vowel harmony rule becomes symmetric and can be formulated as an α-rule.

Pharyngeal harmony being a simplification of fronting harmony may explain the fact that while there are several languages which have shifted from having fronting harmony into having pharyngeal harmony, no example of the opposite development is known. If the two rules are formulated in Chomsky and Halle's feature system, they are equally simple and not related, so Wood's feature system clearly has greater explanatory force in this case. The Mongolian example is also an argument against Fischer-Jørgensen's (1984) criticism of Wood's feature system, among other things based on the fact that it is relatively complicated to handle fronting harmony in it.

6. Rounding harmony

In Ancient Mongolian there was no rounding harmony, and the open round vowels **o* and **ȯ* occurred only in the first syllable of a word. Already in Classical Mongolian, the phenomenon called 'labial attraction' had started, and in some words an open unrounded vowel in the following syllable had assimilated in rounding to a preceding open round vowel, as in the words *mongγol* 'Mongol' (from **moŋγal*) and *nøkør* 'friend' (from **nøker*). This assimilation was not obligatory, and Classical Mongolian has many unassimilated words, such as *olan* 'many' and *køke* 'blue'.

In Khalkha and in most Inner Mongolian dialects, the open vowels have obligatory rounding harmony, so that an open vowel in non-first position is round if, and only if, the two conditions that the first vowel of the word is open and round, and that intervening vowels are either open or neutral (i.e. *i* and, e.g. in Šuluun Höh, *ɪ*) are fulfilled. In Buriat the rounding harmony rule is more complicated, since *ɵ* has been unrounded in certain positions, and has merged with *u* in others (see Poppe (1960a), Bosson (1962b)).

In Oirat there is no rounding harmony, and *o* and *ȯ* occur only in the first syllable of a word (see the examples from standard Kalmyk below). Examples:

	Kalmyk	*Šuluun Höh*	*Khalkha*	
	dola:n	dɔlɔ:	dɔlɔ:	'seven'
	tolha:	tɔlgœ:	tɔlgɔi	'head'
	gøræ:sn	gərə:s	gərə:s	'antilope'
Ablatives	dola:n-a:s	dɔlɔ:n-ɔ:s	dɔlɔ:n-ɔ:s	
	tolha:-ha:s	tɔlgœ:-gɔ:s	tɔlgɔi-gɔ:s	
	gøræ:sn-æ:s	gərə:sn-ə:s	gərə:sn-ə:s	

Non-open non-velar vowels (/i/ and /ɪ/) are neutral and may intervene without interrupting rounding harmony:

Šuluun Höh	*Khalkha*	
ečigdər	ečigdər	'yesterday'
gɔt-ĩ:xɔ̃:	xɔt-ĩ:xɔ:	'town'
nœ:r-ĩ:xɔ̃:	nɔir-ĩ:xɔ:	'sleep'
təmr-ĩ:xə̃:	təmr-ĩ:xə:	'iron'

The last three examples have the reflexive genitive suffix.

Intervening non-open velar vowels (/u/ and /ɑ/) block rounding harmony. Cf. the following examples with causative and perfective converb suffixes:

Šuluun Höh	*Khalkha*	
ɔr	ɔr	'enter'
ɔr-ɔ:d	ɔr-ɔ:d	(perf.)
ɔr-ɑ:l	ɔr-ɑ:l	(caus.)
ɔr-ɑ:l-a:d	ɔr-ɑ:l-a:d	(caus. perf.)
tər	tər	'be born'
tər-ə:d	tər-ə:d	(perf.)
tər-u:l	tər-u:l	(caus.)
tər-u:l-ə:d	tər-u:l-e:d	(caus. perf.)

The rounding harmony rule can be formulated in the following way:

$$(11)\quad \begin{bmatrix} +\text{syll} \\ +\text{open} \end{bmatrix} \rightarrow [+\text{round}] \;/\; C_0 \begin{bmatrix} +\text{syll} \\ +\text{round} \\ +\text{open} \end{bmatrix} (C_0 \begin{bmatrix} +\text{syll} \\ -\text{open} \\ -\text{round} \end{bmatrix})_0 \_\_$$

It may be noted that rounding harmony is found only in those dialects where *y* > *u*, so that [i] has no rounded counterpart. (Exceptions are perhaps the dialects described by Dobu (1964, 1982), which have a secondary /y:/ phoneme developed by umlaut, but exactly how rounding harmony works in these dialects is not clear.) Thus it is possible to deal with the problem of neutral *i* by giving a rule which rounds also *i*, and to unround the resulting [y] by a separate rule. The alleged existence of a rounded front vowel /y/ in Khalkha, which would make this impossible, has served as an argument against a suprasegmental representation of Khalkha vowel harmony, see Anderson (1980: 28), cf. also Chinchor (1979).

In Šuluun Höh, there is one exception: rounding of open palatal vowels seems to be obligatory in roots, but does not take place in suffixes. (This is not stated in Dobu's book, but can be concluded from the examples given there.)

Examples with comitative suffix (for comparison, also Kalmyk forms, without rounding harmony, are given):

Šuluun Höh	*Khalkha*	*Kalmyk*	
ɑ:l-tæ:	ɑ:l-tai	u:l-ta:	'mountain'
ǰɪd-tæ:	ǰad-tai	ǰid-tæ:	'spear'
nar-tæ:	nar-tai	nar-ta:	'sun'
čæ:-tæ:	cai-tai	cæ:-tæ:	'tea'
ɔd-tæ:	ɔd-tɔi	od-ta:	'star'
mœrj-tæ:	mɔri-tɔi	mør-tæ:	'horse'
nɔxœ:-tæ:	nɔxɔi-tɔi	noxa:-ta:	'dog'
xun-te:	xun-tei	kyn-tæ:	'person'
bičig-te:	bičig-tei	bičg-tæ:	'letter'
nər-te:	ner-tei	ner-tæ:	'name'
ɵbs-te:	ɵvs-tei	øvs-tæ:	'grass'
jərɵ̃xø:ləxč-te:	jərɵ̃xi:ləgč-tei		'president'

In Khalkha, there is no diphthong *[ɵi], and for expected **ɵi* in suffixes, *ei* appears. In standard Khalkha (according to Damdinsüren and Osor (1983)), this does not interrupt rounding harmony. For instance, the reflexive form of *ɵvs-tei* is *ɵvs-tei-gɵ:*. Forms such as *ɵvs-tei-gė:* are often found, however. See also Street (1963: 41) and Steriade (1981).

Dobu (1983) does not state whether or not the unrounded vowels in the comitative suffix interrupt rounding harmony in Šuluun Höh, but according to the general rules they should, so that for instance the reflexive comitatives of 'horse' and 'grass' ought to be *mœrj-tæ:-gɑ̃:* (cf. Khalkha *mɔri-tɔi-gɔ:*) and *ɵbs-te:-gə̃:*. There may be some variation also here, since comitatives such as *mœrj-tæ:* are found occasionally in Dobu's book.

7. Vowel alternation in suffixes

In this section, the consequences of the vowel harmony rules for suffix vowels in the different languages are formulated and exemplified.

In a given word in Classical Mongolian, there were three possibilities for suffix vowels:

[+open]	A = {a, e}
[−open, +round]	U = {u, y}
[−open, −round]	i

Open round vowels (*o* and *ö*) do not occur in suffixes. The values of the features 'palatal' and 'velar' (and 'pharyngeal') are determined by vowel harmony. This can be illustrated in the following way:

i	y		u
e	(ø)	a	(o)

The suffixes for agent verbal noun (*-Gči*), imperfect converb (*-jU/čU*), and perfect converb (*-GAd*) exemplify this:

ire	-gči	-jy	-ged	'come'
yje	-gči	-jy	-ged	'see'
kele	-gči	-jy	-ged	'speak'
tøry	-gči	-jy	-ged	'be born'
ira	-γči	-ju	-γad	'expose'
unta	-γči	-ju	-γad	'sleep'
taγara	-γči	-ju	-γad	'fit'
oro	-γči	-ju	-γad	'enter'

In literary Kalmyk the situation is similar to that in Classical Mongolian:

[+open]	A = {a,æ}
[−open, +round]	U = {u, y}
[−open, −round]	i

i	y		u
(e)	(ø)		
æ		a	(o)

Examples with voluntative (*-i:*), causative (*-U:l*), and past tense (*-lA:*) suffixes:

ir	-i:	-y:l	-læ:	'come'
yz	-i:	-y:l	-læ:	'see'
kel	-i:	-y:l	-læ:	'speak'
xær	-i:	-y:l	-læ:	'return'
ø:rd	-i:	-y:l	-læ:	'approach'
unt	-i:	-u:l	-la:	'sleep'
ta:r	-i:	-u:l	-la:	'fit'
or	-i:	-u:l	-la:	'enter'

In Khalkha the situation is like this:

[+open]	A = {a, e, ɵ, ɔ}
[−open, +velar]	U = {u, ʊ}
[−open, −velar]	i

i		u
		ʊ
e		ɵ
	a	ɔ

Here it is not necessary to use the feature 'round' for specifying suffix vowels. This holds for East Mongolian, where *y* has developed into *u*, but not for Classical or West Mongolian. It may be noted that rounding harmony has developed only in those languages where the suffix vowels and the class of neutral vowels can be specified without using the harmonizing feature ('round').

Examples with non-past verbal noun in the accusative (*-x-i:g*); contemporal converb (*-ngU:t*); past tense (*-lA:*), and non-past verbal noun in the comitative (*-x-tAi*):

ir(e)	-x-i:g	-ngu:t	-le:	-x-tei	'come'
uz(e)	-x-i:g	-ngu:t	-le:	-x-tei	'see'
xel(e)	-x-i:g	-ngu:t	-le:	-x-tei	'speak'
tər(ə)	-x-i:g	-ngu:t	-lə:	-x-tei	'be born'
ʊnt(a)	-x-i:g	-ngʊ:t	-la:	-x-tai	'sleep'
ta:r(a)	-x-i:g	-ngʊ:t	-la:	-x-tai	'fit'
ɔr(ɔ)	-x-i:g	-ngʊ:t	-lɔ:	-x-tɔi	'enter'

And finally, in Šuluun Höh:

[−palatal]	A = {a, ə, ɵ, ɔ}
[+palatal, +open]	E = {e, æ}
[+palatal, −open, +velar]	U = {u, ʊ}
[+palatal, −open, −velar]	I = {i, ɪ}

i			u
ɪ			ʊ
e	(ø)	ə	ɵ
æ	(œ)	a	ɔ

Examples with non-past verbal noun in the accusative (*-x-I:g*), contemporal converb (*-ngU:t*), past tense (*-lA:*), and non-past verbal noun in the comitative (*-x-tE:*):

ir(ə)	-x-i:g	-ngu:t	-lə:	-x-te:	'come'
uj̈(ə)	-x-i:g	-ngu:t	-lə:	-x-te:	'see'
xəl(ə)	-x-i:g	-ngu:t	-lə:	-x-te:	'speak'
tər(ə)	-x-i:g	-ngu:t	-lə:	-x-te:	'be born'
ır(a)	-x-ı:g	-ngɷ:t	-la:	-x-tæ:	'expose'
ɷnt(a)	-x-ı:g	-ngɷ:t	-la:	-x-tæ:	'sleep'
xærj(ı)	-x-ı:g	-ngɷ:t	-la:	-x-tæ:	'return'
œ:č(ı)	-x-ı:g	-ngɷ:t	-lɔ:	-x-tæ:	'fall'
ta:r(a)	-x-ı:g	-ngɷ:t	-la:	-x-tæ:	'fit'
ɔr(ɔ)	-x-ı:g	-ngɷ:t	-lɔ:	-x-tæ:	'enter'

8. Conclusion

Recently, several authors with an inadequate knowledge of the language have used Khalkha vowel harmony data in various phonological debates. Many of the conclusions drawn are of a limited value, since an incorrect basis for the vowel harmony system has been assumed, and since the interaction of vowel harmony and rounding harmony has been misunderstood.

In this article I have shown that modern East Mongolian vowel harmony is of the pharyngeal type, similar to the vowel harmony systems in Tungusic languages and in several African languages from different language families.

Since Ancient Mongolian had fronting harmony, the vowel harmony system has changed, and this is a consequence of a vowel shift which has taken place in East Mongolian, involving umlaut and backing of front rounded vowels. This vowel harmony shift is described in terms of generative phonology, and it turns out to be a case of rule simplification if an appropriate feature system is used.

Mongolian vowel harmony has survived in spite of phonological changes which have in many cases affected all the vowels of the language. This was accomplished either by a reclassification of individual words as in Kalmyk, or by changing the phonetic basis for vowel harmony, as in East Mongolian. In both cases, several apparently independent rules have had the joint effect of upholding the phonological principle of vowel harmony (but not necessarily its phonetic implementation).

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