Oroch Vowel Harmony*

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Abstract

In this paper I examine vowel harmony in Oroch, a recently extinct Manchu-Tungusic language. Oroch vowels are subject to the interplay of retracted tongue root (RTR) harmony and rounding harmony. The two kinds of harmony have contrasting effects on neutral vowels. The front vowels /i/ and / æ/ are transparent to RTR harmony, while the vowels /i/, / æ and /u/ are opaque to rounding harmony. Crucially, if the root contains only neutral vowels /i/ and /æ/, the RTR feature of the suffix is unpredictable.

There are several works on Manchu-Tungusic Vowel Harmony, though none of them deal directly with Oroch. Kaun (1995) offers an analysis of languages with similar rounding harmonies in terms of phonetically grounded Optimality Theory (OT). Li (1996) offers a combination of feature architecture and OT, while Zhang (1996) uses contrastive feature specification. However, none of these analyses have an explanation for the distribution of RTR features on suffixes attached to neutral roots.

This paper puts forth a Stratal OT analysis of Oroch vowel harmony, along the lines of Kiparsky (2000). The neutral vowels are assumed to be subject to RTR harmony at the stem level, where the most harmonic candidate wins, but at the word level there is a constraint against [i] bearing [+RTR] feature and against [æ] bearing [−RTR] feature; thus on the surface the effect of RTR harmony is undone on transparent vowels. Thus, the transparency of the neutral vowels is predicted, as well as the distribution of suffixes with neutral roots, the underlying RTR specification of which spreads onto suffixes at the stem level. This is supported by the fact that in related languages, where both [+RTR] and [−RTR] versions of the front vowels exist, the RTR features of the root coincide with the features of the Oroch suffixes.

In addition, the Stratal OT approach allows avoiding unmotivated contrast in the ranking of *GAP constraint for RTR and rounding harmony, required by other analyses to derive the transparency vs. opacity effects of these two harmonies. On the contrary, my Stratal analysis obeys strict locality, i.e. spreading is restricted to adjacent segments. Thus, the problems encountered by previous approaches do not arise under the Stratal approach, which allows a more economic account of the Oroch vowel harmony in terms of a small set of necessary and phonetically grounded constraints, with a coherent ranking predicting the transparency with respect to RTR harmony, opacity with respect to rounding harmony, and suffix harmony triggered by the neutral roots.

1 Introduction

In this paper I examine vowel harmony in Oroch, a recently extinct language belonging to the Southern branch of Manchu-Tungusic languages. Oroch vowels display RTR harmony and rounding harmony. Vowel segments may be classified into three groups, according to participation in harmony:

- target segments, which are affected by harmony,
- opaque[1] segments, which remain unchanged and block the feature spreading,

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- transparent segments, which remain unchanged but do not block the feature spreading.

The same vowel may be opaque to rounding harmony, while transparent to RTR harmony, and different vowels are targets of the two kinds of harmony.

The first type of Oroch vowel harmony is based on the retracted tongue root feature [±RTR]. For example, the vowels /ʊ, a, ɔ/ (and their long counterparts) are [+RTR], and must cooccur: *ʊgda-va-da* 'boat-ACC-FOC[2]' *(*underlying form: */ʊgdA-vA-dA/*[3]*)*, while the vowels /u/ and /ə/ are [−RTR] and cooccur: *xunkə-du-də* 'canoe-DAT-FOC' (underlying form: /*xunkA-dU-dA/)*.

The vowels /i/ and /æ/ are transparent to RTR vowel harmony and may co-occur with both [+RTR] and [−RTR], but they do not block harmony: *ʊgda-ɲi-da* 'boat-3SG-FOC' *(*underlying form: */ʊgdA-ɲi-dA/)*, *xunkə-ɲi-də* 'canoo-3SG-FOC' (underlying form: /*xunkA-ɲi-dA/)*.

The second kind of harmony is based on the roundness feature, e.g. *ɔmɔɔ-vɔ-dɔ* 'lake-ACC-FOC' (underlyingly: /*ɔmAA-vA-dA/)*. However, rounding harmony occurs in rather limited contexts, and is blocked by the neutral front and high vowels: *ɔtɔŋgɔ-dʊ-da* 'kayak- DAT-FOC' (underlyingly: /*ɔtAŋgA-dU-dA/)*.

The low round vowel [ɔ] occurs only in the first syllable, or in the second syllable when preceded by front vowels. It may be followed by vowels /i/, /æ/ and /ʊ/, as well as by harmonizing low round vowels. The vowels /i/, /æ/ and /ʊ/ block rounding harmony, while /i/ and /æ/ are transparent to RTR harmony.

The vowels unaffected by a type of harmony are considered neutral, independently of whether they propagate the harmony or block it. Thus, /i/, /æ/ and /ʊ/ are neutral in respect to rounding harmony, while /i/ and /æ/ are neutral in respect to RTR harmony.

Crucially, if the root contains only neutral vowels /i/ and /æ/, the RTR feature of the suffix is unpredictable. Though in *biti-və* 'we-ACC' and *sikki-da* 'wash-FOC', the roots contain the same vowels /i/, in the first case the suffix is [−RTR], while in the latter it is [+RTR], in spite of the phonetically [−RTR] root.

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[1] Because the terminology of vowel harmony and opacity use the term 'opaque' in opposite contexts, a terminological clarification is necessary: opaque vowels are unaffected by harmony and block it, while transparent vowels are skipped by harmony. At the same time, when referring to misapplication, a phonological generalization is rendered opaque when it is prevented from applying in an environment where it would generally be expected to apply.

[2] Abbreviations: ACC 'accusative', DAT 'dative' , FOC 'focus', 3SG '3rd singular', RTR 'retracted tongue root'

[3] The capital letters signify underspecified vowels in the underlying form; thus I, U are unspecified for RTR feature, and A is a low vowel, underspecified for roundness and RTR.

None of the existing analyses deal with Oroch explicitly and in detail, and, as I will show below, the behavior of the Oroch neutral vowels seems to present problems for every existing account. The fact that the front low vowel [æ] is neutral is not predicted, as every account would have to deny it either the [low] feature, or the [+RTR] feature phonologically, in spite of its phonetic properties and diachronic and synchronic crosslinguistic evidence. The unpredictability of the suffix form with the neutral roots is another, more serious, problem.

The goal of this paper is to provide a unified analysis of the two coexisting kinds of vowel harmony in Oroch, and to examine its consequences for transparency and locality in feature spreading. An analysis in terms of Stratal Optimality Theory (OT) will be developed, where neutral vowels are assumed to be subject to RTR harmony, yet the RTR contrast for front neutral vowels is prevented from surfacing at the word level.

A Stratal OT analysis provides an answer to the problems raised by the ambiguous behavior of Oroch neutral vowels as feature spreaders. One of the important implications of the hypothesis that all segments are affected by RTR harmony would be the universal status of strict locality, i.e. a constraint against skipping is a part of GEN, which generates the wide variety of output candidates.

The texts (Avrorin 1966, 1978), on which this work is based, were collected by V.A. Avrorin and E.P. Lebedeva, with help from an Oroch speaker Tyktamunka, in 1959 during an expedition in the region around Sovetskaja Gavan'. They were recorded by hand in Cyrillic-based phonetic transcription, and some of them were recorded on tape as well. The published materials contain Cyrillic phonemic transcription, translations into Russian, and a vocabulary. The Latinate transcription, glossing and translations to English in all examples are mine. The texts represent folklore, as well as stories about Oroch traditional way of life, history, and personal experiences.

Another valuable source is the Manchu-Tungusic etymological dictionary, (Cincius 1975), subordinate to the Altaic database available on-line (Starostin 2003), and the Oroch grammar (Boldyrev-Avrorin 2001).

In addition, the field sound recordings from an expedition in 2006, headed by Svetlana Toldova, were used, but the competence of the modern speakers does not extend beyond basic passive knowledge, and the pronunciation is largely affected by Russian, which is their main language.

The structure of the paper is as follows. In section 2, I present the Oroch Phonemic Inventory and basic descriptive facts concerning the vowel harmony in Oroch. Section 2.3 is specifically dedicated to the behavior of neutral vowels as harmony triggers, which will turn out crucial for the analysis. Section 3 is the core of the paper where I present my analysis of the vowel harmony. In section 3.1 I describe the constraints required to derive the assymetry of the Oroch Vowel Inventory. Section 3.2 is dedicated to the basic assumptions of Stratal OT. The rest of the section 3 develops a Stratal OT analysis of rounding and RTR harmony, and also shows the phonetic grounding of the constraints used. In section 4, I review some of the previous approaches to Tungusic vowel harmony, and show the problems presented by Oroch to such analyses. Section 5 summarizes the conclusions, and appendix contains some basic sociolinguistic information on the Oroch language.

2 Vowel Harmony / Data

The Oroch vowel harmony is typical for Tungusic languages. According to Li (1996), the Tungusic vowel harmony is based on the presence of retracted tongue root feature.

In Oroch, the vowels /ʊ, a, ɔ/ (and their long counterparts) are [+RTR], /u, ə/, are [–RTR], and /i/ and /æ/ are described as neutral, i.e. transparent to vowel harmony. Oroch agglutinative suffixes harmonize with the stem. The suffixes containing low vowels have three variants, agreeing in RTR and rounding features (e.g. *-da/-də/-dɔ* ‘focus particle’); the suffixes containing the high back vowel (e.g. *-dʊ/-du* ‘dative’) have only [±RTR] contrast, and are unaffected by rounding harmony; the suffixes containing neutral vowels remain unaffected by harmony at all. In the roots, as well, the harmony prevents cooccurrence of vowels from clashing classes.

2.1 Phonemic Inventory

Oroch has a system of 18 consonants, shown in (1), adapted from Avrorin (2001)

(1)						
	p		t			k
	b		d			g
		s			č	x
	v			ž		ɣ
	m		n		ɲ	ŋ
	l	r	j			

The system of 13 vowels is rather asymmetrical. Length is contrastive for all the vowels except /æ/, which is always long.

(2)	Neutral	[−RTR]		[+RTR]
	i/ii		u/uu	ʊ/ʊʊ
				ɔ/ɔɔ
	æ	ə/əə		a/aa

There are 12 diphthongs, also far from forming a symmetrical system. The glide /i/ is neutral, and thus co-occurs with both [+RTR] and [−RTR], and /u/ agrees with respect to RTR feature with the other vowel in the diphthong.

(3)	[− RTR]	iə	əi	əu	ui	iu			
	[+ RTR]	ia	ai	aʊ	ʊi		æi	æʊ	æa

2.2 Data

The root *ʊgda* ‘boat’ contains only [+RTR] vowels, and the suffixes take the [+RTR] form. The [–RTR] suffix is incompatible with this root. The counterfactual non-harmonizing forms are supplied in parentheses:

(4) ʊgda-va-da (*ʊgda-və-də)
boat-ACC-FOC

(5) ʊgda-dʊ-da (*ʊgda-du-də)
boat- DAT-FOC

The neutral vowel /i/ is transparent to RTR harmony, it does not have a [+RTR] counterpart, and does not block the harmony:

(6) ʊgda-ɲi-da (*ʊgda-ɲi-də)
boat-3SG-FOC

The root *xuŋkə* ‘canoe’, on the contrary, contains only [–RTR] vowels, and is, therefore, incompatible with [+RTR] suffixes.

(7) xuŋkə-və-də (*xuŋkə-va-da)
canoe-ACC-FOC

(8) xuŋkə-du-də (*xuŋkə-dʊ-da)
canoe-DAT-FOC

The neutral vowel /i/ in the suffix remains unchanged and unaffecting harmony:

(9) xuŋkə-ɲi-də (*xuŋkə-ɲi-da)
canoe-3SG-FOC

The second kind of harmony is rounding harmony. However, it occurs in rather limited contexts. It only affects low vowels. The low round vowel [ɔ] occurs only in the first syllable (10a,c,d), or in the second syllable when preceded by a front vowel in the first syllable (10b) and may be followed by neutral vowels (10c,d), which block further spreading of the [+round] feature.

(10) a. ɔmɔɔ ‘lake’

b. ikɔ ‘pot’

c. sɔggixa ‘green’

d. xɔlɔmʊkta ‘grapes’

The neutral vowels [i], [æ] and [ʊ] block further spreading of rounding harmony, thus the unrounded form of the suffix must appear after a neutral vowel, even if the root contains a round vowel.

In the example below, the suffix *-dʊ* blocks the roundness spreading, even though the vowel [ʊ] is round itself, because the rounding harmony affects only low vowels. Thus, the *-da* variant of the suffix is selected. The [+RTR] harmony is observed with [ɔ], which does not have a [−RTR] counterpart.

(11) ɔtɔŋgɔ-dʊ-da (*ɔtɔŋgɔ-dʊ-dɔ, *ɔtɔŋgɔ-dʊ-də)
kayak-DAT-FOC

Similarly, in the example below the neutral vowel [i] blocks further spreading of the roundness feature, thus the non-round suffix *-da* is selected. The neutral vowel, however, does not affect the RTR harmony, thus the [+RTR] suffix is used.

(12) ɔtɔŋgɔ- ɲi -da (*ɔtɔŋgɔ-ɲi-dɔ, *ɔtɔŋgɔ-ɲi-də)
kayak- 3SG-FOC

2.3 Neutral vowels as harmony triggers

If the root contains only neutral vowels, the suffix is unpredictable synchronically from inside the Oroch language. However, the agreement coincides with the harmonic properties of the reconstructed Proto-Tungus-Manchu root, as well as the properties of cognate words in languages that preserve the RTR distinction for all vowels. The reconstructed vocalic inventory of Proto-Tungus-Manchu contains both [+RTR] and [−RTR] front vowels, which trigger [RTR] harmony like regular contrasting vowels. For example, in (13), the reconstructed roots, marked with star *(*bue, *uppi, *is)* are [−RTR] and trigger [−RTR] harmony. The idiosyncratic suffix with the neutral Oroch root is also [−RTR] as a legacy of the Proto-Tungus-Manchu spreading.

(13) [−RTR] agreement

	Oroch		Proto-Manchu-Tungusic (Starostin et al. 2003)
a.	biti-və	‘we-ACC’	*bue
b.	ippi-də	‘to sew-FOC’	*uppi
c.	isæ-məči	‘to pull-from.each.other’	*is

In (14), the reconstructed Proto-Manchu-Tungusic roots (**giaxʊa, *silkʊ, *gianam*) are [+RTR], and the suffix used with the neutral root in Oroch is also [+RTR].

(14) [+RTR] agreement

	Oroch		Proto-Manchu-Tungusic
a.	gæki-va	'hawk-ACC'	*giaxʊa
b.	sikki-da	'wash- FOC'	*silkʊ
c.	gæawa-na	'dawn-V'	*gianam

In modern Oroch, according to Avrorin (1968), the phoneme /æ/ is in free variation for some lexical items with /ia/, /iə/ and /i/, as shown in (15). However, such alternations are far from universal and impossible in such words as *ɲæ* 'man', *gæki* 'hawk', *xæsi* 'sound', and many others.

(15)

bæskə	= biəskə	'after all'
bæ-va	= bia-va	'moon-ACC'
badæ	= badi	'more'

Synchronically, /æ/ appears transparent to RTR harmony and opaque to rounding harmony. The starred forms in parentheses are the counterfactual harmonic forms.

(16)

əžæ lənidə	just below	(*əže)
isæ-məči	pull from each other	(*isæ-mači)
ŋənə-mdæ	walk-PART	(*ŋana-mdæ, ŋənə-mde)
ʊža-mdæ	follow-PART	
žaŋgæ-ra	judge	
æʊkta	look through	
gæʊli-xati	went on rowing	
pæampai	magpie	
kæmbɔ	break	
sɔrɔdæ-da	greet-FOC	

Thus, it seems that at least two underlying phonemes ([+RTR] and [–RTR]) surface as [æ], enforcing the harmony on a level preceding the neutralization

2.4 Vowel Cooccurence

The vowels which may co-occur in a root are summarized in the table below, adopted from Avrorin (1968), where '+' stands for two vowels that may cooccur in a root, and '*' signifies that the vowels are incompatible within a single root.

(17) The cooccurrence of vowels in roots

	i	a	ə	u	ʊ	æ	ɔ
i	+	+	+	+	+	+	+
a	+	+	*	*	+	+	*
ə	+	*	+	+	*	+	*
u	+	*	+	+	*	+	*
ʊ	+	+	*	*	+	+	*
æ	+	+	+	+	+	+	*
ɔ	+	*	*	*	do not cooccur in roots, but /ʊ/ is ok in suffix (see ex. 28)	+	+

The neutral vowel [i] is compatible with all the other vowels:

(18)	i + i	biti	'we'
	i + a	inda	'dog
	i + ə	iɲəktə-	'to laugh'
	i + u	idu	'to roll thread into clew '
	i + ʊ	idʊ	'where?'
	i + æ	isæ	'to pull'
	i + ɔ	ikɔ	'pot'

The other neutral vowel [æ] may also co-occurs with every vowel:

(19)	æ + i	xæsi-na	'to sound'
	æ + a	æla	'triton'
	æ + ə	isæ-məči	'to pull-from.each.other'
	æ + u	pæxundə	'to dry in the wind, aerate'
	æ + ʊ	ælʊ-	'to smudge with coal'
	æ + ɔ	kæmbɔ-	'to break'

The low [+RTR] vowel [a] is compatible with neutral vowels:

(20)	a + i	avasi	'where to?'
	a + æ	aalæ	'a kind of berries'

and [+RTR] vowels:

(21)	a + a	amba	'tiger, evil spirit'
	a + ʊ	appʊ-	'to sweep'

The low [−RTR] vowel [ə] is compatible with neutral vowels:

(22)	ə + i	əgdi	'numerous'
	ə + æ	xəggæ	'lowest, the one below'

and [−RTR] vowels:

(23)	ə + u	əmugdə	'stomach'
	ə + ə	əktə	'human skin'

The high back [−RTR] vowel [u] is compatible with neutral vowels:

(24)	u + i	usi	'seeds'
	u + æ	uɲæ-	'to tie plants for drying'

and [−RTR] vowels:

(25)	u + ə	uggə	'heavy'
	u + u	uru-	'to bend'

The high back [+RTR] vowel [ʊ] is compatible with neutral vowels:

(26)	ʊ + i	ʊli	'river'
	ʊ + a	ʊpa	'flour'

and [+RTR] vowels:

(27)	ʊ + ʊ	ʊmʊ	'nest'
	ʊ + æ	ʊsæ	'box'

The low round [+ RTR] vowel [ɔ] does not occur with /a/, but is compatible with itself:

(28)	ɔ + ɔ	sɔrɔdæ-	'to greet'

with neutral vowels:

(29)	ɔ + æ	tɔɔmæ	'later'
	ɔ + i	ɔggi-	'to dry'

and with the high [+RTR] round vowel:

(30) ɔ + ʊ ɔɔsʊ- ‘to become free from ice (about a river in spring)’

Several attempts have been made to describe Tungusic vowel harmony in the OT framework, in particular Li (1996), in terms of Autosegmental Phonology, Zhang (1996) in terms of contrastive underspecification and Kaun (1995) in terms of Phonetically Grounded phonology. None of these works, however, deal specifically with Oroch, and all of the analyses run into severe problems when extended to Oroch and confronted with the behavior of neutral vowels. This paper will consider both feature geometry based approaches and phonetically grounded approaches, and their shortcomings. It will be suggested that the behavior of “neutral” trigger vowels is best analyzed in terms of Stratal OT, which allows a succinct and elegant solution with a considerably smaller number of constraints.

3 Analysis

3.1 Oroch Vowel Inventory and Representations

I will use binary features to define the vowels, although the analysis will work under any representation, so the choice of representation is a theoretical, rather than empirical, question in this case, an in depth discussion of which is beyond the scope of this paper.

[Low] and [back] features will be used, because only low back vowels are subject to rounding harmony, so this representation makes the formulation of the constraints more concise, as will be seen in the subsequent analysis sections. Thus, the following representations are assumed for the surface inventory. The starred shaded vowels are non-existent on the surface.

(31)

	i	*ɪ	*e	æ	ə	a	u	ʊ	*o	ɔ
±back	−	−	−	−	+	+	+	+	+	+
±low	−	−	+	+	+	+	−	−	+	+
±RTR	−	+	−	+	−	+	−	+	−	+
±round							+	+	+	+

A certain asymmetry immediately becomes apparent. There are gaps for /o/, the [−RTR] counterpart of /ɔ/, and /i/ is lacking a [+RTR] counterpart, while /æ/ is lacking a [−RTR] counterpart. Besides, there are no front round vowels.

However, the Richness of The Base principle claims that the set of possible inputs is universal, so there are no restrictions upon the input vowel inventory. Thus, the limited vowel set must be derived from an unlimited set of input vowels by phonological constraints (*ɪ, *e, *y, *o). However, all of these restrictions are phonetically grounded.

The constraints that will be introduced to account for Oroch vowel inventory and distribution are listed below:

(32) *FRONTROUND *[y]
*LOWBACKRD, −RTR *[o]
*LOWFRONT, −RTR *[e]
*HIFRONT, +RTR *[ɪ]
LICENCE[ɔ]: The low round RTR vowel [ɔ] is licensed only in the first syllable or in the second syllable after a front vowel.
*ROLO: Vowels should not be simultaneously specified [+ round] and [+ low].
IDENT: Vowel features must be faithful to the underlying specification.

The [+round] feature cannot be associated with front vowels in Oroch. There are no front round vowels in Oroch, and the front vowels are opaque to rounding harmony. Thus, a *FRONTROUND constraint, outranking IDENT, is required, which is motivated by the fact that rounding is more audible on the back vowels, all the more that crosslinguistically, roundness is less common on front vowels than on back vowels.

The distribution of the RTR feature on the front vowels can be phonetically motivated by the crosslinguistic tendencies described in Archangeli and Pulleyblank (1994). They argue for a connection between tongue root features and height and backness features, based on the physical properties of the vocal tract. They show that raising or fronting of the tongue body tends to correlate with tongue root advancement. The relevant implicational statements are given below, where the tendency in (33a) is stronger than in (33b):

(33) a. If [+low] then [−ATR]
b. If [−back] then [+ATR]

If tongue root advancement [ATR] feature is less likely to occur with low vowels, it is not surprising for tongue root retraction [RTR] to be preferable with low back round vowels. Thus, the following constraints emerge to account for the three unpaired vowels, deriving the surface Oroch vowel inventory:

(34) *LOWBACK, −RTR *[o][4]
*LOWFRONT, −RTR *[e]
*HIFRONT, +RTR *[ɪ]

[4] Note, however, that non-round [ə] does exist, so the *[LowBack, −RTR] is not sufficient alone to rule out a vowel, but only in combination with the *ROLO constraint.

However, the underlying vowel inventory must include the paired front vowels, as can be seen from the suffix patterns with roots containing only front vowels, where the suffix RTR features depend on the underlying representation of the root.[5] Thus, the underlying phonemic inventory of Oroch is closer to that of cognate languages that preserve the RTR distinction for /i/ and /ɪ/ (e.g. Bayinna Orochen, Li 1996). The segments marked bold are absent in the surface inventory, but present underlyingly.

(35) Bayinna Orochen

nonRTR	i ii	u uu	ə əə	***o oo***	***ie***
RTR	***ɪ ɪɪ***	ʊ ʊʊ	a aa	ɔ ɔɔ	***ɪɛ*** (corresponding to Oroch [æ])

Underlying Oroch Inventory

nonRTR	i ii	u uu	ə əə		***e***
RTR	***ɪ ɪɪ***	ʊ ʊʊ	a aa	ɔ ɔɔ	æ

Surface Oroch Inventory

nonRTR	i ii	u uu	ə əə		
RTR		ʊ ʊʊ	a aa	ɔ ɔɔ	æ

The tableaux below derive the surface and the underlying Oroch vowel inventory from the constraints introduced:

(36) Surface Inventory:

	*FrontRd	*LoBkRd[-RTR]	*LoFront[-RTR]	*HiFront[+RTR]	Ident
y	*!				
☞i					
ɪ				*!	
e			*!		
☞æ					
☞ə					
☞a					
☞u					
☞ʊ					
o		*!			
☞ɔ					

[5] So, there actually three vowel inventories: one unrestricted, according to ROTB, the second intermediate underlying inventory, after the stem level processes, and the third one we see on the surface after all the word level processes also take place.

(37) Underlying Inventory:

	*FRONTRD	*LOBKRD[-RTR]	IDENT	*LOFRONT[-RTR]	*HIFRONT[+RTR]
y	*!				
☞i					
☞ɪ					*
☞e				*	
☞æ					
☞ə					
☞a					
☞u					
☞ʊ					
o		*!			
☞ɔ					

The limited distribution of the round low vowels also has a phonetic explanation. Not only does /ɔ/ lack a [−RTR] pair, but it may only occur in the initial syllable, or following a front vowel. This can be explained by the *ROUNDLOW (*ROLO) constraint against lip rounding in combination with low jaw position, suggested by Kaun (1995):

(38) *ROLO: Vowels should not be simultaneously specified [+ round] and [+ low].

The [−RTR] round low vowel /o/ is most marked (violating both *ROLO and *LOW[−RTR]) and absent in Oroch.

Another constraint is required to ensure that the [+RTR] low round vowels do exist, at least in the first syllable and after neutral vowels, where they are best perceived (either by virtue of the generally enhanced perceptibility of the first syllable, or by contrast with the initial front vowel, which is the furthest opposite in the vowel space). The licensing constraint I suggest is as follows:

(39) LICENCE[ɔ]: The low round RTR vowel [ɔ] is licensed only in the first syllable or in the second syllable after a front vowel.

Though such formulation might look somewhat *ad hoc*, it is phonetically grounded. When the [+round] feature is not associated with the first syllable, where it is most perceptible, it follows [i] and [æ], located on the opposite corner of the vowel space, and this contrast increases perceptibility. Thus, the two most perceptible positions (initial syllable or after a contrasting vowel) are united by the constraint in (39).

The constraint PARSE[RD]INIT in (40), suggested by Kaun (1995) for many of the rounding harmony systems, is insufficient for Oroch. It is stated as follows:

(40) PARSE[RD]INIT: A feature [+round] affiliated with an initial syllable must be parsed in phonological structure.

Such a constraint, according to Kaun is clearly required independently in the Altaic languages, where contrastive rounding is often limited to initial syllables, as predicted if this PARSE constraint outranks *ROLO. It is both cross-linguistically and perceptually motivated, and would account for most Oroch cases, where the round vowel is in the first syllable. However, the licensing constraint in (39) is necessary, to ensure that front vowels, to which the [+round] feature cannot be linked, do not count as initial syllable. Then the [+round] is preserved whenever affiliated with the first *back* vowel.

The interaction of *ROLO and LICENCE[ɔ] leads to the limited distribution of the round vowels in Oroch. LICENCE[ɔ] outranks *ROLO, thus low round vowels are not completely banned from the language. The fact that low round vowels do not appear elsewhere is claimed to arise from the *ROLO constraint which rules out vowels that are simultaneously specified [+round] and [+low] whenever the LICENCE[ɔ] constraint is inactive.

However, the Richness of The Base principle claims that the set of possible inputs is universal, thus a vowel specified for [+round] and [−high] might exist in any position in the input, since the input is not subject to surface constraints. Yet, even in that case, the combination of [+low] and [+round] features would not be preserved. Consider a hypothetical input in the tableau below (41), which might exist, according to ROTB, but would never surface because the candidate (b) containing the non-round vowel is selected by *ROLO. No matter whether the second vowel in the input is round, the output is the same, containing the non-round vowel (unless, of course, the low round vowel is word initial or after a front vowel.) Hence, the analysis complies with the ROTB hypothesis.

(41)

/ʊgdɔ/	LICENCE[ɔ]	*ROLO	IDENT
a. ʊgdɔ	*!	*	
b. ☞ʊgda			*

Thus, a small number of phonetically grounded constraints describes both the asymmetries of the Oroch surface vowel inventory and the limited distribution of low round vowels.

3.2 Stratal OT

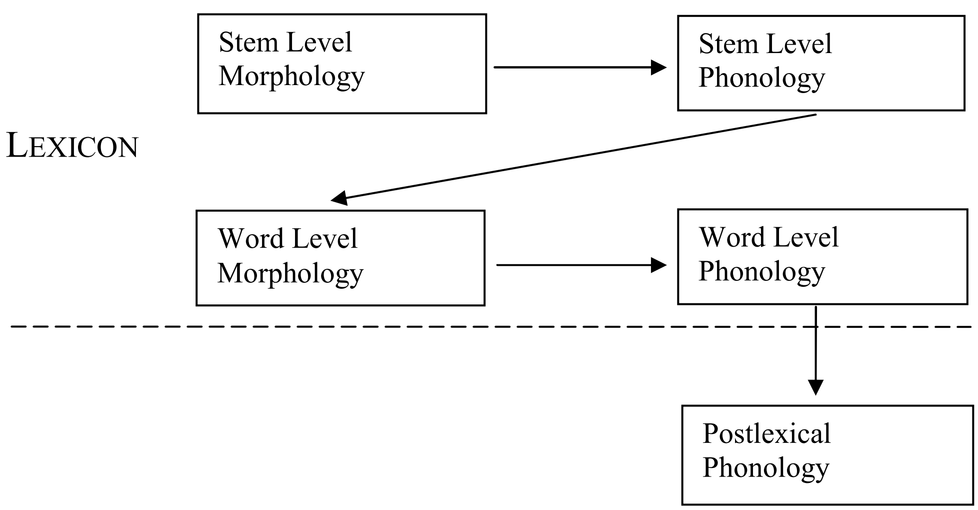
When faced with opacity, the classic parallel OT turns out too restrictive, as it cannot handle overapplication and underapplication of rules, or the cyclic inheritance of phonological properties from bases to derivatives. There are extensions to parallel OT to deal with opacity, such as Output-Output correspondence or sympathy constraints

(McCarthy 1997, 1999). However, these approaches demand an introduction of new types of faithfulness constraints, which is a deviation from the theoretical claim of full parallelism, and they are also controversial both descriptively and explanatory (see Kiparsky (2000) for examples which cannot be described in terms of parallel OT alone).

On the other hand, Stratal Optimality Theory, as presented by, for example, Bermudez-Otero (in preparation) and Kiparsky (2000, 2001), allows a morphologically motivated stratally organized version of OT, with parallelism preserved at each level. The goal of Stratal OT (Kiparsky 2000) is to reduce cyclicity to Input/Output faithfulness, and opacity to interlevel constraint masking. Thus, if α is the constraint system of some domain (say, stems) and β the constraint system of a larger domain (word level or postlexical) then β's markedness constraints can override α's constraints, thus leading to opacity.

While the subsystems are OT constraint systems that may differ in ranking, each level (stratum) is a parallel constraint system of the Classical OT type (no Output-Output constraints, Turbidity, Sympathy, etc.). The strata interface serially as input/output, i.e. the output of the stem level is the input word level, and the output of the word level is the input for the postlexical level as shown in the diagram below (from Kiparsky 1982).

(42)



For example stress is inherited from bases to derivatives because it is assigned cyclically (Kiparsky 2007). The cyclic inheritance explains the following contrast: *imàginátion* vs. *sèdimentátion,* where *imàginátion* inherits the secondary stress from *imágine.* Thus, *imágine* is the output of the stem level, and the input to the word level. At the word level, the suffix *-ation* is added, and the IDENT-STRESS is high ranked. Thus, the most faithful candidate is selected by Input-Output faithfulness.

(43)

Word Level		
Input: [[imágin] ation]	Ident-Stress	Align-Left
a. (ìma)gi(ná)tion	!*	
b. ☞ i(màgi)(ná)tion		*

In a fully parallel model, without the faithfulness to the stem-level output *imágine,* the ungrammatical candidate (a) in tableau (43) would win as satisfying the Align-Left constraints, just like the grammatical candidate *sèdimentátion* is selected by Align-Left (unless an OO-Faithfulness constraint is introduced, which would be a digression from full parallelism).

(44)

Fully Parallel Model, deriving the ungrammatical candidate	
Input: [[imágin] ation]	Align-Left
a. 💣 (ìma)gi(ná)tion	
b. i(màgi)(ná)tion	!*
Input: [sedimentátion]	Align-Left
a. ☞(sèdi)mentátion	
b. se(dìmen)tátion	!*

3.3 Stratal OT and Oroch neutral vowels.

The behavior of the Oroch neutral vowels, unaffected by harmony, is a typical case of **misapplication,** as described by Kiparsky (1973):

(45)

- Let some phonological, morphological, or syntactic generalization $\mathcal{Q}$ cause the environment for phonological generalization $\mathcal{P}$ to exist in representation $\mathcal{R}$. If nonetheless $\mathcal{P}$ fails to apply to $\mathcal{R}$, $\mathcal{P}$ is said to underapply in $\mathcal{R}$.
- Let some phonological, morphological, or syntactic generalization $\mathcal{Q}$ prevent the environment for phonological generalization $\mathcal{P}$ from existing in representation $\mathcal{R}$.
- If nonetheless $\mathcal{P}$ applies to $\mathcal{R}$, $\mathcal{P}$ is said to overapply in $\mathcal{R}$.
- In both cases, we say that $\mathcal{P}$ has been rendered opaque by $\mathcal{Q}$.

The phonological generalization 𝒫 is vowel harmony: if the root contains a [+RTR] vowel, the suffix is expected to be [+RTR]. The environment for 𝒫 is created when the root contains a [+RTR] vowel: e.g. *isæ* ‘to pull’. Thus, the suffix is expected to be also [+RTR], yet the suffix fails to harmonize (*isæ-məči*, **isæ-mačı)* thus leading to *underapplication*.

If, on the other hand, the root contains only [−RTR] vowels, e.g. *sikki* ‘wash’, the suffix containing the [+RTR] vowel *sikki-da* ‘wash-FOC’ (**sikki-də*) is a case of *overapplication*.

If we adhere to the assumption that there are only two levels of representation (input and output), an unnecessarily complicated constraint ranking emerges to account for underapplication. The input is not a possible source of any generalization about the opaque properties of neutral vowels because of Richness of the Base hypothesis (Prince and Smolensky 2004 (1993); Smolensky 1996), which says that the set of possible inputs to the grammar is universal, i.e. free of language specific restrictions.

The tableau below show how a fully parallel account (without O-O faithfulness constraints) cannot account for overapplication of RTR harmony, while predicting correctly the harmonic candidate.

(46)

FULLY PARALLEL MODEL, deriving the ungrammatical candidate	
input: /sikki-dA/	VOWELS MUST AGREE IN RTR
a. sikki-da	*!
b. 💣sikki-də	
input: /ippi-dA/	VOWELS MUST AGREE IN RTR
a. ippi-da	*!
b. ☞ippi-də	

In the stratal OT framework, the source of the underapplication of RTR vowel harmony to neutral vowels is the input-output identity constraint. Opacity thus emerges from the serial interaction between cycles; within each cycle, however, phonological processes must apply transparently, as the input-output mapping is effected through parallel candidate evaluation in the ordinary optimality-theoretic fashion. As shown in section 3.1, there is an underlying contrast between /i/ and /ı/, and between /æ/ and /e/, which is active on stem level, but neutralized on the word level. Then, the neutral root with harmonic suffix is derived as follows:

1. The input for the stem level contains a root specified for RTR features, and a suffix lacking RTR features: ippi-dA; sıkkı-dA.
2. The output of the stem level, after the application of the first set of the constraints which enforce full spreading, contains only harmonic vowels: ippi-də, sıkkı-da

3. The output of the stem level (ippi-də, sıkkı-da) is the input for the word level
4. The output of the word level, selected by the second set of constraints, which prohibit high front [+RTR] vowels, does not preserve the contrast, thus violating harmony: ippi-də, sikki-da

Thus, the Stratal OT allows a compact constraint ranking at each level (derived in the next two sections), allowing a much simpler treatment of opacity of the Oroch neutral vowels to RTR harmony, while not preventing them from blocking the rounding harmony. The assumption that spreading can apply only between adjacent eligible segments (vowels) is active in the analysis.

A stratified constraint system, in this way, has the advantage of maintaining a restrictive and well-defined constraint inventory, as originally envisaged in OT. More importantly, it achieves some genuine explanations by relating the stratification motivated by opacity and cyclicity to the intrinsic morphological and prosodic constituency of words and phrases, as characterized by the Stem, Word, and Postlexical levels of Lexical Phonology and Morphology (Kiparsky 2000, Booij 1996; 1997; Orgun 1996; Bermudez-Otero 1999). E.g. in English, the assignment of stress is morphologically motivated, which is an advantage for the learnability of the system.

To sum up, the stratal approach allows to reflect change, naturalness, and the phonology/morphology interface, while at the same time providing a more compact system with a consistent constraint ranking at each level and straightforward inter-level faithfulness constraints.

3.4 Rounding harmony

The constraints adopted are perceptually motivated in the spirit of Kaun's (1995) cross-linguistic analysis of rounding vowel harmony. However, it must be noted that, as opposed to Kaun (1995), I am assuming strict locality in the spirit of Walker (1999), i.e. gapping is prohibited in GEN, which does not generate candidates with spreading skipping across intervening segments, as will be discussed in more detail in the section on RTR harmony. Then there is no necessity to include the *GAP constraint in the ranking, which is a considerable advantage for the learnability of the system.

The key idea of Kaun (1995) is that 'harmony is grounded in an extension of the temporal span associated with some perceptually vulnerable quality'. Rounding and RTR features are such vulnerable qualities in case of Oroch. By increasing the listener's exposure to the quality in question, harmony increases the probability that the listener will accurately identify that quality. This accounts, among other things, for the fact that the long vowels in Bayinna Orochen fail to trigger harmony: it is seen as unnecessary, since the listener's exposure to the rounding quality is already long enough.

Accordingly, harmony is expected where the rounding feature is least audible and feature enhancement is most needed. Rounding is least salient in low vowels, due to the relatively low jaw position, and less robust lip position. Linker's (1982) data indicate that non-high rounded vowels tend to be less rounded than high rounded vowels, as it takes more effort to round a low vowel, due to jaw aperture, though it is not impossible. Therefore, low round vowels are more likely to become triggers of rounding harmony, as most vulnerable to misperception. Hence, the EXTEND constraints, requiring the spreading. The limited distribution of the round vowels, discussed in section 3.1, is another consequence: the low round vowel /ɔ/, which is harder to perceive as round, occurs only in the first syllable, or following front vowels. The first syllable is the position for enhanced perception, and front vowels are at the opposite end of the vowel space, which makes the contrast maximal, thus improving perception.

The articulatorily motivated UNIFORMITY constraint which states that the autosegment [+round] may not be multiply-linked to vowel positions which are distinctly specified for height and place, accounts for the unaffectedness of high vowels by rounding harmony. Kaun (1995) suggests that UNIFORMITY constraints reflect a requirement that a given articulatory instruction, or autosegment, have a uniform execution mechanism throughout its span of association. Hence, a single autosegment in the phonology corresponds to a single gesture in the phonetics; the need for articulatory adjustments in the execution of a single articulatory gesture should be avoided. Thus, the constraints for the rounding harmony are listed below:

(47) EXTEND[RD]IF[LO]: a feature [+ round] affiliated with a low vowel must spread to the adjacent low vowel.

(48) UNIFORMITY: The autosegment [+ round] may not be multiply linked to slots bearing distinct height and place feature specifications[6].

The EXTEND constraint is limited to low vowels, because the [+round] feature is less audible on low vowels. Thus, roundness spreads from low vowels, but not from the high round vowels /u/and /ʊ/. The tableau below derives the rounding harmony in *ikɔ-dɔ* 'pot-FOC' at the stem level.

(49)

/ ikɔ-dA/	EXTEND[RD]IF[LO]	*ROLO
a. ikɔ-da	*!	
b. ☞ikɔ-dɔ		*

The specification of [+ low] on the EXTEND constraint combined with the UNIFORMITY and *ROLO constraint restricts roundness spreading to low back vowels. Though high vowels must be specified for [+round] as well as low ones, the spreading does not affect

[6] This is a slight modification of Kaun's formulation; in her analysis uniformity only applied to height.

them, since a [+round] feature shared by a heigh and a low vowel would fatally violate both UNIFORMITY and *ROLO constraints.

IDENT and UNIFORM constraints must outrank the EXTEND constraint. If EXTEND constraint outranked IDENT, the ungrammatical second candidate would win in (50), since in that case all vowels would be subject to harmony, at the cost of height feature preservation. However, the candidate (b) is ruled out, as violating high ranked height faithfulness. Thus, *ikɔ-dʊ* 'pot-DAT' is derived.

(50)

/ ikɔ-dU/	IDENT[HI]	EXTEND[RD]IF[LO]
a. ☞ ikɔ-dʊ		*
b. ikɔ-dɔ	*!	

Similarly, UNIFORM constraint must outrank the EXTEND constraint, as the rounding harmony exists, yet it does not spread to high vowels, as can be seen from their blocking effect. The ungrammatical candidate (b) violates the UNIFORM constraint, as [round] feature is shared by high and low segments and propagated to the underspecified suffix. In the grammatical candidate (a) the harmony does not spread to the suffix /-dA/, because the intervening suffix /-dU/ is prevented from participating in harmony and propagating roundness by the UNIFORM constraint.

(51)

/ ikɔ-dU-dA/	IDENT[HI]	UNIFORM	EXTEND[RD]IF[LO]
a. ☞ ikɔ-dʊ-da RD RD			*
b. ikɔ-dʊ-dɔ RD		*!	
c. ikɔ-dɔ-dɔ RD	*!		

Yet, though phonetically grounded OT is capable of explaining the opacity of neutral vowels with respect to rounding harmony, such an analysis on its own is incapable of accounting fully for the RTR distribution in Oroch, hence its combination with Stratal OT is necessary, which will account for the transparent neutral vowels.

3.5 RTR harmony

As shown in section 3.3, RTR harmony can only be accounted in terms of the Stratal OT. Except the behavior of neutral vowels, RTR harmony is omnipresent, thus a single constraint EXTEND[RTR] would suffice. It is assumed that at the stem level all vowels are affected by RTR harmony, but at a subsequent level the unpaired vowels surface as neutral.

Hence, the vowel inventory is different at the two levels, as shown in section 3.1. On the surface, the vowels [ɪ] and [e] are absent, and harmony is the only trace of their underlying presence.

The striking contrast in the behavior of neutral vowels in Oroch and Manchu raises doubts about legitimacy of calling Oroch /i/ and /æ/ neutral vowels. According to Dresher and Zhang (2000), the Manchu neutral vowels /i/ and /u/, which co-occur with both sets of root-vowels, can only be followed by suffixes containing RTR vowels, described as default value, selected in the absence of clues from the preceding neutral vowel. So, in Manchu, neutrality is reflected on harmony targets, which display a default value after neutral vowels, while in Oroch, rather, an ambiguity of triggers takes place, where targets still display varied behavior.

The Manchu examples in (52), from Dresher and Zhang (2000) illustrate how the neutral /i/ may follow both [+RTR] and [−RTR] vowels in a suffix (52 a-c), but a root containing /i/ is only compatible with the [+RTR] suffix (52 d,e).

(52)	a.	səjə-ci	'wagoner'
	b.	caga-ci	'clerk'
	c.	hasi-ri	'dark purple'
	d.	fili-kan	'somewhat solid'
	e.	sifi-kʊ	'hairpin'

In Oroch, however, the "neutral" vowels may be followed by either set of vowels. As can be seen from the cross-family comparison and etymological data, the tongue root feature triggered by a neutral root corresponds to the Proto-Manchu-Tungusic feature. In related languages where the contrast is preserved for all vowels, a [+RTR] vowel appears in the roots that trigger [+RTR] harmony.

(53)		Oroch		Proto-Manchu-Tungusic	
	a.	gvæna	'to dawn'	*giańam	'dawn'
	b.	isæ-məči	'rope pulling game'	*xise	'to beat'

This distinction is impossible to capture by a phonetic surface theory without appealing to underlying structure, since there is no surface difference in the roots. A possible solution is to allow two levels: on the first level the RTR contrast is preserved and triggers harmony. At a subsequent layer, the RTR contrast is neutralized, but the harmony triggered by it remains. Once we accept existence of a level where the RTR contrast of neutral vowels is preserved, the transparency of the neutral vowels may be explained straightforwardly, without the appeal to segment skipping. The RTR feature spreads to all the relevant segments at first, but is neutralized for some segments on the surface.

The Stratal Optimality Theory provides a convenient framework for such division into two levels: stem and word level. The tableau below shows the derivation of the harmony pattern observed in *ʊgdaɲɪda* 'boat'. EXTENDRTR constraint enforces the spreading of the RTR feature. It is highly ranked at the stem level, thus ensuring that full spreading takes place and *ʊgdaɲɪda* wins. The *HIFRONTRTR constraint blocks the /ɪ/ vowel. A parallel *LOWFRONT[−RTR] constraint blocks the /e/ vowel.

The IDENTRTR constraint makes sure that the RTR features present in the input are preserved in the output. At the word level, the IDENT constraint ensures the input output correspondence. The input for the word level is the output of the stem level, so the constraint ensures that the optimal output candidate corresponds to the candidate that won at the stem level: *ʊgdaɲɪda*. Thus, the candidate (c), closest to the output of the stem level is selected out of the candidates satisfying the high ranking *HIFRONTRTR constraint at the word level. Skipping segments is not allowed, so the EXTENDRTR constraint is violated by any output where not all vowels are [+RTR]. The tableau below derives *ʊgdaɲɪda* 'boat-3SG-FOC'

(54)

STEM LEVEL			
ʊgdA-nI-dA	EXTENDRTR	IDENTRTR	*HIFRONTRTR (*ɪ)
a. ☞ʊgdaɲɪda			*
b. ugdəɲidə		*!	
c. ʊgdaɲida	*!		
WORD LEVEL			
ʊgda-ɲɪ-da	*HIFRONTRTR (*ɪ)	IDENTRTR	EXTENDRTR
a. ʊgdaɲɪda	*!		
b. ugdəɲidə		*!	
c. ☞ʊgdaɲida			*

Similarly, the roots containing neutral vowels are assumed to have an input specified for [RTR] feature, which spreads at the stem level and is neutralized at the word level, after determining the suffix. The *HIFRONTRTR constraint is high ranked at the word level (as shown in (55)), thus the candidates violating it are not considered in the tableau below.

(55)

STEM LEVEL			
ise-mAčI	EXTENDRTR	IDENTRTR	*LOWFRONT[−RTR](*e)
a. ☞isemәči			*
b. ɪsæmačɪ		*!	
c. isæmačɪ	*!		

WORD LEVEL			
ise-mәči	*LOFRONT[−RTR](*e)	IDENTRTR	EXTENDRTR
a. ise-mәči	*!		
b. isæ-mači		**!	*
c.☞isæ-mәči		*	*

A parallel example deriving a neutral root with [+RTR] suffix is shown below. The root is specified as [+RTR] at the input. The EXTEND constraint ensures that all the vowels are affected by harmony at the stem level, thus selecting candidate (a).

(56)

STEM LEVEL		
gækɪ-va	EXTENDRTR	IDENTRTR
a. ☞gækɪ -va		
b. geki-vә		*!
c. gæki-vә	*!	

At the word level, the high ranked constraints against HIFRONT[+RTR] and against LOWFRONT[−RTR] rule out the most faithful candidate (a), thus the root is neutralized, but the suffix remains faithful to the input.

(57)

WORD LEVEL			
gækɪ-va	*HIFRONTRTR(*ɪ)	IDENTRTR	EXTENDRTR
a. gækɪ-va	*!		
b. gæki-vә		**!	*
c.☞gæki-va		*	*

Thus, the existence of two levels with different vowel inventories and different constraint ranking allows for a straightforward ranking at each level, leading to an explanatorily adequate model deriving the suffix variety with 'neutral' vowels, where all the relevant segments are affected by spreading, thus avoiding the questionable segment skipping by spreading.

4 Problems of previous approaches to Tungusic vowel harmony

This section examines previous analyses of vowel harmony in related Manchu-Tungusic languages, and shows why none of them can account for Oroch vowel harmony. In particular, none of the analyses can predict the behavior of the front vowels [æ] and [i] as harmony triggers.

4.1 Contrastive Specification

The Contrastive specification approach imposes ordered binary divisions on sets of vowels that are not specified for redundant features. Such an approach was suggested by Zhang (1996) to explain the harmony patterns in Tungus languages of China. A contrastive hierarchy was created, such that the non-contrastive phonetic features did not play a role in triggering harmony.

The key role is assigned to ordering of contrastive features in Successive Binary Algorithm proposed by Dresher (1998) and Dresher, Piggot and Rice (1994):

(58) a. In the initial state, all sounds are assumed to be variants of a single phoneme.
b. If the set is found to have more than one phoneme, a binary distinction is made on the basis of one of the universal set of distinctive features; this cut divides the inventory into a marked set and an unmarked set.
c. Repeat step (b) in each set, dividing each remaining set until all distinctive sounds have been differentiated.

This algorithm was used to derscribe Manchu vowel harmony. The vowel system of Written Manchu is very similar to Oroch, with the exception of /æ/ being present in Oroch but not in Manchu. In both languages, /i/ is neutral, though phonetically [−RTR] and high round vowels do not participate in rounding harmony, and only the RTR low round vowel /ɔ/ is present in the system.

An interesting difference, which will turn out crucial, is that in Manchu, the stems containing only neutral vowel /i/ trigger RTR harmony on suffixes. Phonetically, however, [i] is [−RTR], so its disharmonic cooccurrence with the [+RTR] form of the suffix is unexpected:

(59)	fili	‘solid’	fili-kan	‘somewhat solid’	(Manchu)

However, when /i/ is in a position to undergo harmony, it may occur with both [+RTR] and [−RTR] vowels as a neutral vowel unaffected by harmony:

(60)	a.	səjən	‘wagon’	səjə-ci	‘wagoner’	(Manchu)
	b.	cagan	‘books’	caga-ci	‘clerk’	

Now, consider Successive Binary Algorithm applied to the Oroch vowel system. As in the case of Manchu, neither RTR nor Labial specification can be applied initially, since that would lead to neutral vowels participating in the contrast. According to the algorithm in (58), a binary distinction would divide the entire inventory into two sets ([+RTR] and [−RTR], or [+round] and [−round]), without a possibility for a third set (the front vowels, compatible with both sets) to remain neutral. This outcome is undesirable, thus the cuts that do not scope over the entire vowel set, must only apply after the neutral vowels have been set aside by a more universal distinction.

Thus, the choice is between using backness or height features, which also happen to be more basic distinctions crosslinguistically. If the feature Low were assigned first, as was done by Dresher and Zhang (2000), it would lead to /æ/ specified as Low, along with /a/, / ə/ and / ɔ/, which contrast for roundness. This outcome is undesirable, since then it would be unexpected that /æ/ does not participate in the rounding contrast along with the other low vowels. However, if Dorsal feature is assigned first, the problem does not arise. Then, the division is as follows:

(61)

	DORSAL	
i		u
		ʊ
æ		
	ə	ɔ
	a	

Then the vowels can be divided according to the Low feature:

(62)

	DORSAL		
i		u	
		ʊ	
æ			
Low	ə	ɔ	Low
	a		

At this point it is necessary to order the RTR and Labial features. If the labial feature were assigned first, /ɔ/ would be unspecified for RTR and thus it would be expected to act neutrally with respect to RTR harmony. However, this does not appear to be the case: /ɔ/ cooccurs only with RTR vowels. Therefore, the RTR contrast must scope over Labial contrast:

(63)

i		u	
		ʊ	RTR
æ	ə		
	a	ɔ	RTR

Thus, Labial feature only applies to the low [+RTR] vowel.

(64)

	DORSAL			
i		u		
		ʊ RTR		
æ	ə			LOW
	a	ɔ	RTR	
		Labial		

After this last cut, all the vowels are fully contrasted:

(65)

	i	æ	ə	a	u	ʊ	ɔ
Dorsal			+	+	+	+	+
Low		+	+	+			+
Labial							+
RTR				+		+	+

Then, the Oroch harmony patterns would follow. The constraints introduced by Kaun (1995) may still apply in light of contrastive specification. Then both rounding harmony and RTR harmony would be achieved by EXTEND and UNIFORM constraints, where for Rounding Harmony UNIFORMITY would refer to height and backness, while for RTR harmony it would just refer to backness. The neutral vowels blocking effect for rounding harmony would be achieved by high ranking of *GAP constraint, which would block skipping, allowed for RTR harmony.

However, the neutral roots combining with both sets of prefixes are an unsolvable problem for this analysis. The EXTEND constraint is only active on dorsal vowels, since the neutral front vowels are compatible with any vowels independently of their specificaton. But in that case, the ambiguity of neutral vowels with respect to the RTR features of the underlying form cannot be reflected in contrastive specification, and the shape of the suffix selected appears arbitrary.

The fact that the analysis denies the round feature to high vowels, is another potential problem; see also Nevins (2005) who argues against underspecification approach to Manchu, showing that high vowels must be specified for [+round] as well as low ones.

4.2 Li's Autosegmental analysis of Tungusic vowel harmony

Bing Li (1996) provides a systematic and detailed description of Tungusic vowel harmony, and a theoretical analysis of the harmony using Autosegmental Phonology, Dependency Phonology and Optimality Theory. He provides an in-depth analysis of vowel harmony in Bayinna Orochen, Xunke Orochen, Solon, Classical Manchu, Sanjiazi Manchu and Sibe – Tungusic languages, spoken in China. The vowel systems of these languages, though related to Oroch, differ slightly; so attempting to extend Li's analysis to Oroch runs into several problems.

The segmental structure of the vowels bears most of the weight of the analysis. The round feature is claimed to be redundant for /u/, and thus absent on high vowels, where the back feature is sufficient to distinguish front unrounded vs. back rounded vowels. This ensures that rounding harmony only affects low vowels. RTR feature is a secondary feature, like roundness, and spreads from there.

To account for neutral vowels in Xunke Orochen, Li invokes a constraint against front RTR vowels:

(66) *FRONT/RTR: Co-occurence of a PF [Front] and [RTR] is disfavored.

The constraint is undominated, crucially over-ranking *GAP, and blocks spreading of RTR onto neutral /i/, while allowing the spreading to continue over it.

Oroch, however, presents a problem for such an analysis, as it has a neutral vowel /æ/, which is Front and [+RTR], but otherwise behaves exactly like /i/, being unaffected by RTR harmony and transparent to it. Yet, under Li's autosegmental approach, the RTR feature must be present and spreading, if the vowel is phonetically RTR and the feature is not redundant. Denying RTR feature to /æ/ is impossible in light of its harmonic behavior in diphthongs, where it only appears with RTR and neutral vowels, i.e. /æʊ/, /æa/, and /æi/ are possible diphthongs, while */æu/ and */æə/, do not exist. It is, however, possible to say that RTR feature is redundant, since /æ/ is the only low front vowel, and that the RTR harmony in diphthongs is a matter of phonetics, rather than phonology. The neutral behavior of front vowels would be then explained, since RTR contrasting feature is redundant for both. However, the choice of the suffix with a neutral root depends on the underlying RTR specification of the neutral vowel, and reflecting this link in an autosegmental analysis is impossible.

Invoking Obligatory Contour Principle for rounding harmony, where a whole separate feature sharing system is introduced, and denying round feature to high round vowels are other weaknesses of such analysis.

Thus, the Oroch vowels harmony cannot be analyzed in terms of dependency phonology alone like some related Manchu-Tungusic languages can, in spite of numerous similarities in the harmonic systems. Both Li's and Zhang's analyses run into the same problem of being incapable of capturing the pattern purely representationally. Both invoke unmotivated opposite constraint rankings for RTR and rounding harmony (with *GAP ranked high for rounding and low for RTR), both deny the round status to high vowels, and, worst of all, neither analysis can say anything about the connection of the suffix to the underlying representation of a root neutral on the surface.

4.3 Kaun's Phonetically grounded approach

The constraint-based analysis presented in Kaun (1995) characterizes the observed typological rounding harmony patterns as resulting from the interaction of substantive functional principles. According to Kaun, harmony occurs to prolong a feature, otherwise hard to perceive, enhancing the probability that it will be interpreted correctly by the listener. On the basis of this assumption, a small set of phonetically motivated universal constraints is suggested, some of which were used in my analysis of Oroch rounding harmony in section 3.4.

Below is the tableau deriving the rounding harmony in *ikɔ-dʊ-da* 'pot-DAT-FOC' from Kaun's constraints. The *GAP constraint, which was assumed part of GEN in the stratal analysis and, accordingly, not introduced, forbids linking to non-consecutive segments. The [+round] feature is floating in the input, but it is a property of the lexical item /ikA/, as well as [+RTR] feature.

(67)

/ikA-dU-dA/ [+round]	MAX	*GAP	UNIFORM	EXTEND[ROUND]
a. ☞ikɔ-dʊ-da [+round]				*
b. ikɔ - dʊ-dɔ [+round]			*!	
c. ikɔ-dʊ-dɔ [+round]		*!		
d. ikɔ-dɔ-dɔ [+round]	*!			

Below is a perceptually motivated parallel tableau for Oroch RTR harmony. Parallel to the [round] feature, the RTR feature is floating in the input, while place features are pre-linked. The RTR feature extends to the suffix, skipping the neutral vowel, because *GAP is low ranked, unlike for rounding. The UNIFORMITY constraint refers only to backness (i.e. both segments must be [+back] for RTR feature to spread), unlike Rounding harmony, where it also referred to height.

The tableau below derives *inda-ɲi-da* 'dog-3SG-FOC'

(68)

indA-ɲi-dA [+RTR]	UNIFORMITY	EXTEND RTR	*GAP
a. ☞inda-ɲi-da [+RTR]			*
b. inda-ɲi-də [+RTR]		*!	
c. inda- ɲɪ- da [+RTR]	*!		

Both the contrastive underspecification and phonetically based approaches run into the same problem, which is the neutral behavior of the phoneme /æ/, whether it is treated as high or as low. The unpaired low front vowel is unusual for Tungusic languages. It is only present in Udihe (Nikolaeva & Tolskaya 2001) and Oroch, and also occurs in Lamut and Bikin Nanaj as an RTR counterpart of /e/.

In Oroch it is always long and is described by Avrorin as slightly diphthongal, starting with an ultra-short [i]. It also participates in diphthongs /æʊ/ and /æa/. Though Li (1996) mentions these diphthongs in his brief description of Oroch as variants of /aʊ/ and /aa/, they seem to be clearly contrastive in texts, e.g. minimal pair *gæava* 'dawn' - *gaava* 'take'. Avrorin also lists /æi/ among other diphthongs, but I have not found any instances of it in the corpora available, except for the one case he cites as the example (*tanæi-ɲi* 'he/she reads').

Harmonically, /æ/ behaves as a neutral vowel both with respect to RTR harmony and rounding harmony. It may either follow or precede any vowel, and may trigger [±RTR] harmony as a lexical property of the root. At the same time, in diphthongs it is only compatible with [+RTR] vowels, and is phonetically [+RTR]. Its neutral behavior can be explained historically: it is derived from the diphthongs /iɛ/, /iə/, and /ai/, and retains the harmonic features of its ancestor. Crucially, and fatally for the existing accounts, there is no synchronic reason for the suffix choice with neutral stems, as discussed in section 3.2 on neutral vowels.

Harmonically, /æ/ behaves as a neutral vowel both with respect to RTR harmony and rounding harmony. Yet, the constraints in (67) would lead one to expect it to be subject to rounding harmony, as a low vowel.

Then it is necessary to also exclude front vowels from rounding feature spreading. Since crosslinguistically, front vowels are less likely to be rounded than the back vowels, and low vowels are also less likely to be rounded (as shown in the discussion of *RoLo constraint in section 3.1) there might be a constraint against roundness contrast on front vowels. Then the Uniformity constraint might prohibit spreading on high and front vowels, demanding uniform place as well as height.

The neutral vowels, which are opaque to rounding harmony, are transparent to RTR harmony. This difference can be achieved by demoting the *Gap constraint below Extend constraint, thus allowing the [RTR] spreading of a feature to skip over front vowels.

The perceptual motivation for the promotion of the Extend constraint may arise from the relatively low audibility of RTR feature, which makes it even more crucial to extend such feature to make it perceptible. With this reranking, the constraints suggested by Kaun (1995) for rounding, may be adapted for RTR spreading are:

(69) EXTEND [RTR]: The autosegment [+RTR] must be associated to all available vocalic positions within a word.

UNIFORM[RTR]: The autosegment [+RTR] may not be multiply linked to slots bearing distinct backness feature specifications.

*GAP: The autosegment [+RTR] may not be linked to non-consecutive slots.

The contrasting rankings of these constraints, deriving transparency with respect to RTR harmony and opacity in respect to rounding harmony, are as follows:

(70) UNIFORM[RTR] >> EXTEND [RTR] >> *GAP

(71) UNIFORM[ROUND] >> *GAP >> EXTEND [ROUND]

The formulation of UNIFORMITY constraint for RTR harmony is similar to the one for Rounding Harmony, except it is more restrictive for rounding harmony, demanding both height and place uniformity. For RTR harmony, on the other hand, only sharing of RTR autosegment by a front and a back vowel would constitute a violation. The RTR cut might be phonetically motivated by the markedness of the contrast for front vowels, discussed in Archangeli and Pulleyblank (1994), and in section 3.1. However, the phonetic markedness is insufficient to account for the behavior of [æ], which is a front [+RTR] vowel.

Any parallel solution is far from fully satisfactory, requiring numerous questionable assumptions; diachronic and synchronic crosslinguistic data make it even more problematic. The fact that in Oroch the "neutral" vowels may be followed by either set of vowels is impossible to capture by a phonetic surface theory without appealing to underlying structure, since there is no surface difference in the roots. Thus, the contrast cannot be captured purely in representational terms, as sections 4.1 and 4.2 show, nor can the contrast be fully phonetically grounded and described by constraint interaction, as this section shows.

Once we accept, as Stratal OT does, the existence of a level where the RTR contrast of neutral vowels is preserved, the transparency of the neutral vowels may be explained straightforwardly, without the appeal to segment skipping. The RTR feature spreads to all the relevant segments at first, but is neutralized for some segments on the surface. Thus, Stratal OT remains preferable.

5 Conclusion

The Oroch vowel harmony provides a challenging ground to test the existing theories of vowel harmony. The asymmetric vowel system, unique for Manchu-Tungusic languages, and the unpredictability of suffixes with neutral roots provide a serious problem for parallel OT, while they could be easily described with Stratal OT. Then, the neutral vowels would be assumed to be subject to RTR harmony at stem level, where the most harmonic candidate wins. Yet, at the word level there is a constraint against [i] bearing [+RTR] feature and against [æ] bearing [−RTR] feature, thus on the surface the effect of RTR harmony is undone on transparent vowels.

The existence of two kinds of vowel harmony, and presence of both transparency and opacity of neutral vowels with respect to harmony in the same language bears upon the debate whether spreading occurs only to adjacent segments, or skipping is possible (i.e. the status of the *GAP constraint). A parallel approach would demand two different rankings of *GAP present in the language to account for the two patterns encountered with neutral vowels. A Stratal approach would allow the *GAP constraint to be a part of GEN, i.e. the spreading to restricted to adjacent segments.

Postulating a stem level with a distinct vowel inventory and fully harmonizing underlying representations, as the Stratal OT does, is a novel and promising approach in Manchu-Tungusic Phonology, which would be particularly interesting to explore further in field work, especially in light of language change and attrition.

6 APPENDIX

6.1 The Oroch language

Oroch is a nearly extinct language belonging to the Southern branch of Manchu-Tungusic languages, closely related to Udihe and Nanai.

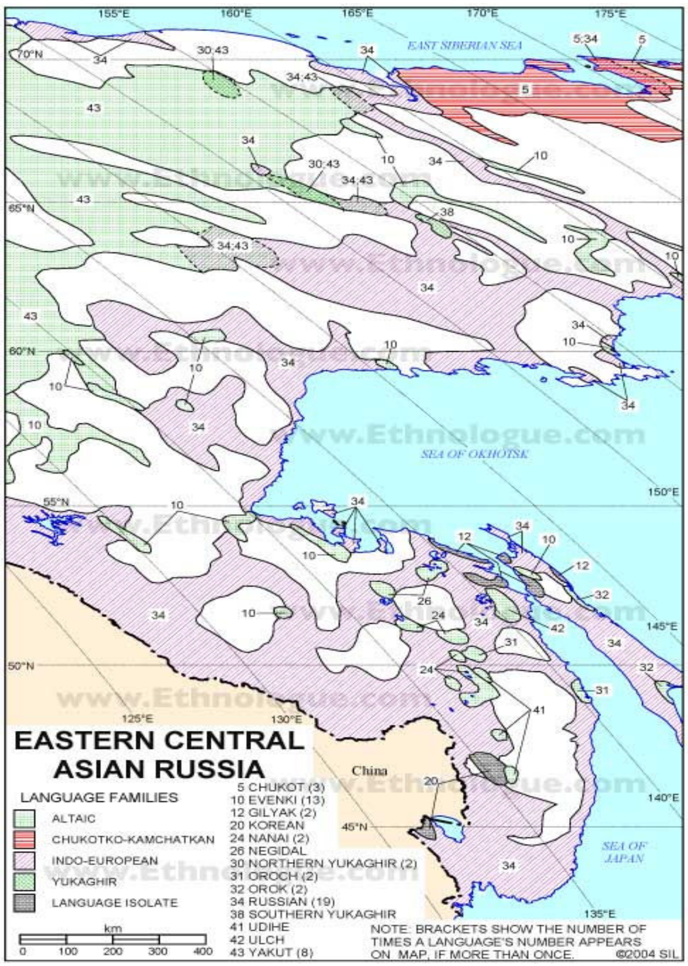
The classification of Tungusic languages is a rather complicated issue and has been subject to much discussion. According to the traditional classification (Cincius 1949), Oroch belongs to the Southern Tungus group, along with Udihe, Orok, Ulch, Nanai and Manchu:

- **Altaic**[7]
  - **Tungus**
    - **Northern**
      - Even
      - Evenki
      - Oroqen
      - Negidal
    - **Southern**
      - **Southeast**
        - Nanaj
        - Udehe
        - Oroch
      - **Southwest**
        - Jurchen
        - Manchu
        - Xibe

[7] Gordon, Raymond G., Jr. (ed.), 2005. Ethnologue: Languages of the World, Fifteenth edition. Dallas, Tex.: SIL International. Online version: http://www.ethnologue.com/.

Benzing (1956) denies it the status of a separate language, uniting it with Udehe. Sunik (1968) suggests a tripartite classification, putting Oroch into intermediate group with Nanaj, Ulch, Orok and Udihe. Menges (1968) also puts it into an intermediate group in the tripartite division, but unites it with Solon, Negidal, and Udihe.

In 2001, the Oroch people lived in the Khabarovsk region mostly along rivers flowing to the Pacific and along the tributaries of the Amur River in the town of Sovetskaja Gavan' and its environs. There used to be a second group in the Komsomolsk district in the settlement of Novoje Ommi near the town of Komsomolsk-upon-Amur (Komsomolsk-na-Amure). A small group lived on the Sakhalin Island. The closest neighbors of Oroch have been Udihe, Nanai, Ulch and Evenki. Oroch phonetics has been affected by constant language contact with Russian. The map below, adopted from http://www.ethnologue.com/ shows the Oroch settlements and their neighbours.



The number of Orochs has been rapidly decreasing, and the last expedition in summer 2006 did not find any fully competent speakers. According to Li (1996) there were 1200 Oroches at the time, 500 of whom were native speakers. In 2000 there were 930. According to the 2002 census, there were 686 Orochs in Russia, and over 80 %

considered Russian, rather than Oroch, their native tongue. The census data might not reflect the real numbers, as it was based on self report, and thus was greatly affected by the relative prestige of minority nationalities. Thus, in the years when it was prestigious and convenient to be Oroch, the numbers escalated considerably.

In September 2001 a sociolinguistic expedition, organized by E. Perekhvalskaya, worked in the Russian Far East , aiming to describe the competence of Orochs in their native language. It turned out that all people over sixty had used the Oroch language with their parents and grandparents in childhood, but now the majority of them understand speech of the elders but answers them mostly in Russian; thus, they only possess passive knowledge limited to a set of formulas. Those who spoke Oroch, were mainly people of over 75 years of age in 2001, and also mostly communicated in Russian among themselves.

Oroch never had a writing system, thus the only source of data is the texts recorded during several expeditions, thus the sources for phonetic research are scarce.

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