Phonological Contrast and Phonetics in Manchu Vowel Systems[*]

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0. Introduction

We argue that the phonological patterning of a phoneme in a grammar is influenced by its contrastive status. A change in this status can lead to a change in its phonological behavior, with little or no outward change in its phonetics. However, the new phonological status of a phoneme may affect its phonetic realizations. Since acquisition of phonological representations is mediated through the phonetics, the proposed analysis posits a mutual interdependence between phonetics and phonology. The synchronic and diachronic patterning of Manchu vowel systems provide evidence in support of this position, as well as for a particular way of understanding contrast.

    We will first consider the vowel system of Written Manchu, also called Classical Manchu (Ard 1984, Li 1996) or Literary Manchu (Seong 1989). It is the language of the documents of the Qing (Ching) dynasty (1644-1911) in China. We will then look at diachronic developments that led to the later Manchu dialects, Spoken Manchu (Zhao 1989, Ji et al. 1989) and Xibe (Li and Zhong 1986).

1. The Vowel System of Written Manchu

The vowel system of Written Manchu is shown in (1).

(1) Written Manchu (Zhang 1996)

Written Manchu has six contrastive vowel phonemes. Given the phonetics of the vowels, we might think that Written Manchu has four or five height classes, but in fact it has only two, as indicated by the horizontal line. There is a set of relatively high vowels above the line and a set of relatively low vowels below the line.

Zhang (1996) has argued that the distinction between /u/ ~ /ʊ/ and /ə/ ~ /a/ has to do with the tongue root: the first vowel in each pair is ATR (Advanced Tongue Root), the second is not. ATR vowels tend to be higher than their non-ATR counterparts, which accounts for the difference in height that accompanies the ATR contrast. Li (1996) also proposes that these contrasts are based on the tongue root. He, however, argues that Retracted Tongue Root ([RTR]) is the marked feature that distinguishes the pairs. Zhang (1996) and Zhang and Dresher (2000) provide evidence that [ATR] is marked in Written Manchu.

1.1.   ATR Harmony in Written Manchu

All vowels in a word apart from /i/ must agree with respect to ATR. This harmony is most clearly seen in the case of /ə/ and /a/: suffixes with these vowels alternate depending on the ATR value of the stem vowels, as in (2).

(2) ATR harmony in Written Manchu: /ə/ ~ /a/
      a. ATR suffixes
          həhə   'woman'   həhə-ŋgə   'female'
          susə   'coarse'   susə-də-   'make coarsely'
      b. RTR suffixes
          aɢa   'rain'   aɢa-ŋɢa   'of rain'
          χʊrχa   'fishing net'   χʊrχa-da- 'catch in a net'

Similarly, /u/ alternates with /ʊ/, as in the suffixes in (3).

(3) ATR harmony in Written Manchu: /u/ ~ /ʊ/
      a. ATR suffixes
          hərə-   'ladle out'   hərə-ku   'ladle'
          səhəhun 'vertical'   səhə-huri   'towering high'
      b. RTR suffixes
          baqta-   'contain'   baqta-qʊ   'internal organs'
          laqdaχʊn 'drooping'   laqda-χʊri 'fully drooping'

This latter alternation is apparent only after back consonants, however. The back (dorsal) consonants manifest an allophonic phonetic alternation depending on the [ATR] value of the following vowel: velars [k, g, h] occur before ATR vowels, including [u], and uvulars [q, ɢ, χ] occur before non-ATR vowels, including [ʊ]. In other contexts, /u/ and /ʊ/ merge at the surface into [u], except for a few sporadic examples. This neutralization does not affect the behaviour of /ʊ/ with respect to ATR harmony, as shown in (4). In (4a) [u] derives from /u/, and patterns with ATR vowels; in (4b), [u] derives from /ʊ/, and patterns with non-ATR vowels.

(4) Dual patterning of [u]
      a. ATR harmony with /u/
          dʐuwə   'two'   dʐuwə-də- 'lean to two sides'
          səktu   'clever'   səktu-kən 'somewhat clever'
      b. RTR vowels with /ʊ/
          dulba   'careless'   dulba-da- 'act carelessly'
          datʂun   'sharp'   datʂu-qan 'somewhat sharp'

The vowel /i/, though phonetically ATR, is neutral when in position to undergo harmony, as shown in (5).

(5) ATR harmony in Written Manchu: /i/ is neutral
    a.   With ATR vowels

itṣə	'new'	itṣə-lə	'make new'
sidərə-	'hobble'	sidərə-shun	'hobbled/lame'
sədẓən	'wagon'	sədẓə-tṣi	'wagoner'

    b.   With RTR vowels

|			
baqtṣin	'opponent'	baqtṣi-la-	'oppose'
bandẓin	'appearance'	bandẓi-sχʊn	'appearance'
tṣaɢan	'books'	tṣaɢa-tṣi	'clerk'

However, when /i/ is in a position to trigger harmony, it occurs only with non-ATR vowels, as in (6).

(6) Stems with only /i/: Suffixes with non-ATR vowels
    a.   With /a/ suffix

ili-	'stand'	ili-χa	'stood'
itṣi	'direction'	itṣi-ŋɢa	'having direction'

    b.   With /ʊ/ suffix

idẓi-	'put in order'	idẓi-sχʊn	'obedient'
sifi-	'stick in the hair'	sifi-qʊ	'hairpin'

There thus appears to be only one /i/ phoneme in Written Manchu. Moreover, this phoneme is not specified as being [ATR], unlike /ə/ and /u/. Why not, given that /i/ is phonetically ATR? Intuitively, we might say it is because /ə/ and /u/ have non-ATR 'partners', whereas /i/ does not, as displayed in (7). But a similar explanation will not suffice to account for labial harmony.

(7) Written Manchu: Sets of [ATR] partners

i			u	+
			ʊ	−

	ə	+	ɔ	
	a	−		
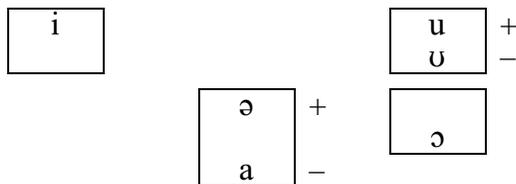
1.2.   Labial Harmony in Written Manchu

Written Manchu also has a process of labial harmony (Zhang 1996, Zhang and Dresher 1996, Walker 2001). A suffix vowel /a/ becomes /ɔ/ if preceded by two successive /ɔ/ vowels (8a). Thus, labial harmony is not triggered by a single short or long /ɔ/ (8b), nor by the high round vowels (8c, d).

(8) Labial harmony in Written Manchu
    a.

	bɔtṣɔ	'colour'	bɔtṣɔ-ŋɢɔ	'coloured'
	fɔχɔlɔn	'short'	fɔχɔlɔ-qɔn	'somewhat short'
b.	dɔ-	'alight (birds)'	dɔ-na-	'alight in swarm'
	dɔɔ-	'cross (river)'	dɔɔ-na-	'go to cross'

c.	ɢulu	'plain'	ɢulu-kən	'somewhat plain'
	kumun	'music'	kumu-ŋɡə	'noisy'
d.	χʊdun	'fast'	χʊdu-qan	'somewhat fast'
	dursun	'form'	dursu-ŋɢa	'having form'

Clearly, /ɔ/ and /a/ are 'partners' with respect to the feature [labial]. But why aren't /u/ and /i/? The diagram in (9) appears to parallel (7).

(9) Written Manchu: Sets of [labial] partners
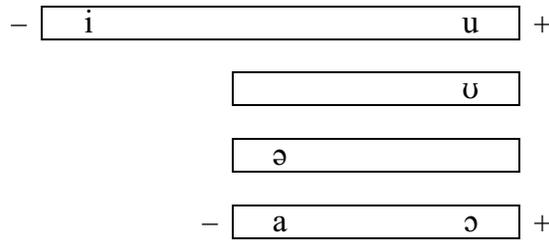
We will argue that it has something to do with /i/ being [coronal]; the evidence is that it causes palatalization of consonants. The specification of /i/ for [coronal] prevents the nonlow vowels from being phonologically specified for [labial], for reasons we will make clear.

1.3.   Phonological Feature Specifications of Written Manchu Vowels

Our brief survey of the phonology of Written Manchu vowels has revealed that we require four vowel features to be active in the phonology: a height feature, which we will call [low]; two place features, [coronal] and [labial]; and a tongue root feature, [ATR]. We have also found positive evidence from palatalization that /i/ is specified for [coronal], and from ATR harmony that it must not be specified for [ATR], despite its surface phonetics. In the case of the high back vowels, there is evidence from silence that they are not specified for [labial], again belying their surface phonetics, and in contrast to /ɔ/, which must be specified [labial] in order to trigger labial harmony.

Putting these observations together, we have found positive evidence for the following feature specifications of Written Manchu vowels:

(10)   Feature matrix for Written Manchu vowels: Privative features

Phoneme	/i/	/u/	/ʊ/	/ə/	/a/	/ɔ/
[low]				√	√	√
[coronal]	√					
[labial]						√
[ATR]		√		√		

The representations in (10) are underspecified in two different ways. The features in (10) are privative; that is, they have one value (the marked value). Underspecification of this kind is not, strictly speaking, underspecification at all, since there are no available values that could be filled in. Privativity, however, does not account for all the blanks in (10), for some marked specifications are also missing: /i/ is not specified for [ATR], and /u/ and /ʊ/ are not specified for [labial]. The motivation for leaving these values blank has so far been empirical: these representations give the best account of the phonological patterning of the

Written Manchu vowels. What we require now is a theory that gives us precisely these specifications. Our claim is that the absence of marked specifications in (10) is bound up with the notion of contrast, and it is to this topic that we now turn.

2. Contrastive Specification by a Hierarchy of Features
The approach we will adopt has roots in early work (Prague School) on contrastive features. The idea is that to determine contrastiveness of features, it is necessary to determine their relative *scope*, or *ordering*. Thus, Trubetzkoy (1939/1969: 102-103) observes that in the Polabian vowel system, a 'certain hierarchy existed' whereby the back ~ front contrast is higher than the rounded ~ unrounded one, the latter being a subclassification of the front vowels. Trubetzkoy's rationale for this analysis is that palatalization in consonants is neutralized before all front vowels and before 'the maximally open vowel a which stood outside the classes of timbre.' Also, the oppositions between back and front vowels are constant, but those between rounded and unrounded vowels of the same height are neutralizable. The vowel system, according to Trubetzkoy's contrastive distinctions, is given in (11), where the feature [back] has wider scope than does [rounded].

(11)   Polabian (Trubetzkoy 1969: 102-3): [back] > [rounded]

Front		Back
(Unrounded)	Rounded	
i	ü	u
ê	ö	o
e		ɑ
a		

In another example Trubetzkoy observes that Greek has a bilabial stop /p/ and labiodental fricatives /f v/, and a postdental stop /t/ and interdental fricatives /θ ð/. Is the primary contrast one of stop vs. fricative or of place? Trubetzkoy appeals to 'parallel' relations between stops and fricatives at different places. In the sibilant and dorsal series (/ts s z/ and /k x ɣ/, respectively), the contrast is unambiguously one of stop versus fricative, since stops and fricatives occur at exactly the same place of articulation. By parallelism, he proposes that the same contrast should apply to the ambiguous cases, which leads to the conclusion that the minor place splits are phonologically irrelevant. The inventory that emerges is given in (12).

(12)   Greek: major place, voicing, occlusion > minor place

| | Labial | | Apical | | | Dorsal |
	bilabial	labiodental	interdental	postdental	sibilant	dorsal
voiceless stops	p			t	ts	k
voiceless fricatives		f	θ		s	x
voiced fricatives		v	ð		z	ɣ

In French, however, Trubetzkoy (1939/1969:126) argues for a split labial series. 'For in the entire French consonant system there is not a single phoneme pair in which the relation spirant : occlusive would occur in its pure form.' Following this analysis to its logical conclusion (n. 93), he disputes that there is an opposition between occlusives and spirants in French because degree of occlusion cannot be regarded independently of position of articulation. The chart in (13) is based on one given by Martinet (1964), who adopts Trubetzkoy's analysis.
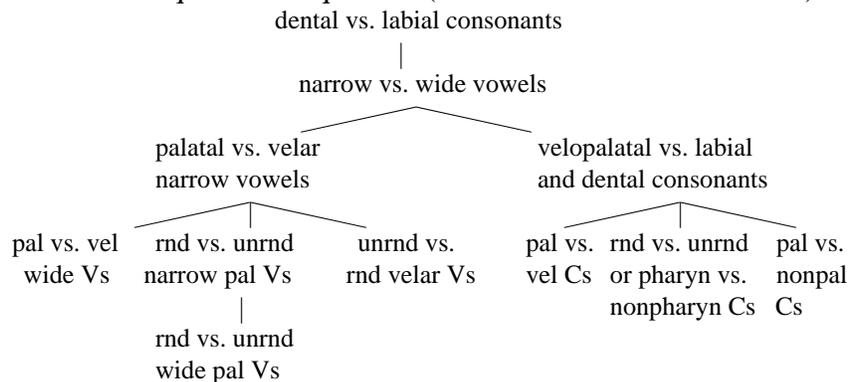
(13)   French obstruents (based on Martinet 1964:65)

	bilabial	labio-dental	apical	alveolar	pre-palatal	dorso-velar
voiceless	p	f	t	s	š	k
voiced	b	v	d	z	ž	g

Thus, Greek and French require a different ordering of the continuant feature relative to minor place features. Trubetzkoy's discussion implies that place features take scope over occlusion (French) unless an occlusion contrast is needed anyway (parallelism, Greek).

The contrastive hierarchy had its heyday in the 1950s, when it was proposed by Jakobson and Halle in a number of publications, including *Fundamentals of Language* (1956) and Halle's *Sound Pattern of Russian* (1959). Jakobson and Halle (1956) refer to this hierarchy as the 'dichotomous scale', and adduce 'several weighty arguments' in support of this hierarchical approach to feature specification. One argument involves language acquisition. They propose that the order of these contrastive splits is partially fixed, thereby allowing for certain developmental sequences and ruling out others. The sequence in (14), for example, concerns oral resonance (primary and secondary place) features.

(14)   Predicted acquisition sequences (Jakobson and Halle 1956: 41)

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                        dental vs. labial consonants
                                    |
                         narrow vs. wide vowels
                    _____|_____
                   |                                       |
           palatal vs. velar                       velopalatal vs. labial
           narrow vowels                           and dental consonants
        _____|_____                      _____|_____
       |         |         |                    |         |         |
pal vs. vel  rnd vs. unrnd  unrnd vs.      pal vs.  rnd vs. unrnd   pal vs.
wide Vs      narrow pal Vs  rnd velar Vs   vel Cs   or pharyn vs.   nonpal
                  |                                 nonpharyn Cs    Cs
             rnd vs. unrnd
             wide pal Vs
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See Rice and Avery (1995) for a more recent application of this idea to the acquisition of representations. On this view, a natural way of determining contrast is by splitting the inventory by means of successive divisions, governed by an ordering of features. An algorithm corresponding to this idea, which we call the Successive Division Algorithm (SDA), is given in (15) (Dresher 1998a, b, 2002, 2003, and Mackenzie and Dresher this volume).

(15)   Successive Division Algorithm
   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. The selected feature is *contrastive* for all members of these sets.
   c. Repeat step (b) in each set with the next feature in the hierarchy, dividing each remaining set until all distinctive sounds have been differentiated.
   d. If a feature has not been designated as contrastive for a phoneme, then it is *redundant* for that phoneme.

We assume that the ordering of features can vary within limits; to the extent that variation is permitted, learners must fix the order based on language-particular phonological and phonetic evidence (see the papers in Hall 2003 for further recent studies in contrast from this perspective).

3. The Contrastive Hierarchy of the Written Manchu Vowel System

The patterning of the Written Manchu vowel system is consistent with the contrastive hierarchy in (16).

(16)   Written Manchu contrastive hierarchy
         [low] > [coronal] > [labial] > [ATR]

The fact that labial harmony is confined to the low vowels suggests that the height contrast is more fundamental than the labial contrast: labial harmony operates within a domain defined by the feature [low]. This conclusion is supported by the evidence that the high vowels have no contrastive specification for [labial]. In terms of the SDA, this suggests that the feature [low] has wider scope than [labial].

Similarly, we can establish that [coronal] must take precedence over [labial]. For if [labial] > [coronal], then the nonlow back vowels would be designated as [labial], and /i/ would not require a specification for [coronal]. The ordering [coronal] > [labial] gives us the desired specifications.

Evidently, the feature [coronal] is not contrastive among the [low] vowels because none of these vowels meet the requirements for coronality. Therefore, [coronal] fails to make any contrasts in the [low] region, and so the way is open for [labial], the next feature in the hierarchy, to be assigned to /ɔ/.

We have observed that /i/ has no phonological [ATR] feature. Since /i/ is phonetically [ATR], its lack of such a specification in the phonology must be due, on the approach taken here, to its contrastive status. We have also seen that /i/ is specified for [coronal]. Considering the relative scopes of these features, it must be the case that [coronal] takes scope over [ATR]. For then, /i/, which is the only [coronal] vowel, would already be distinguished from all other vowels, and so would not be eligible to receive any further specifications. On this ordering, the feature [ATR] is needed in the nonlow vowels only to distinguish /u/ from /ʊ/.

The sets of [ATR] partners in (7) suggest that [labial] > [ATR]. For then [ATR] is relevant only to /ə/ and /a/ among the [low] vowels, and not to /ɔ/.

Finally, because Written Manchu has only one potentially [coronal] vowel, /i/, we obtain the same results with either [low] or [coronal] taking precedence. Zhang has observed that a two-height system is very stable across all the Manchu-Tungus languages surveyed in Zhang 1996, suggesting that the division into two height classes is a basic property of these vowel systems. This would argue in favour of ordering [low] highest. Thus, we arrive at the Written Manchu contrastive hierarchy shown in (16).

4. The Evolution of the Manchu Vowel System

Subsequent changes in the Manchu vowel system support our analysis of Written Manchu and the general approach to contrast it is based on, and demonstrate the interplay between phonological patterning and phonetics. The vowels /ə/ and /u/ will undergo changes in their phonological representations and behaviour without any big phonetic change at first. We will show how their ambiguous status leads learners to make changes in the grammar that later influence their phonetics.

Spoken Manchu (Zhao 1989, Ji et al. 1989) is a later form of Written Manchu. It displays some interesting continuities with the older form of the language, as well as some striking differences that shed further light on the role of contrast in phonology. The vowel system of Spoken Manchu is presented in (17).

(17)   Spoken Manchu (based on Zhao 1989, Ji et al. 1989)

i	y	ə	u
ɛ		a	ɔ

In comparing this vowel system with that of Written Manchu in (1), we note a number of differences, which we tabulate in (18). We will argue that change (18a) sets the stage for (18b), and that (18c) follows from (18b).

(18)   Differences between Written Manchu and Spoken Manchu vowel systems
        a. Spoken Manchu no longer has a contrast between /u/ and /ʊ/.
        b. In Spoken Manchu /ə/ is a nonlow vowel, in Written Manchu it is a low ATR counterpart to /a/.
        c. Spoken Manchu has added coronal phonemes /y/ and /ɛ/.

We will begin with the first change. We observed that in Written Manchu the contrast between /u/ and /ʊ/ was already neutralized to [u] in most contexts, surviving only after velar/uvular consonants and sporadically in other contexts. It is no surprise, therefore, to see this neutralization continue to completion in Spoken Manchu, resulting in the total merger of /u/ and /ʊ/ into [u] and the complete loss of the /ʊ/ phoneme.

In a contrast-driven approach, the loss of a contrast in one part of the vowel system could have wider effects. In the Written Manchu system, the /u/ ~ /ʊ/ contrast involves the feature [ATR], just like the /ə/ ~ /a/ contrast. The unity of the [ATR] contrast is made more salient by the rule of ATR harmony, which clearly indicates to language learners that the vowels are to be sorted into [ATR] and non-ATR sets. But with the loss of /ʊ/, the position of [ATR] in the system becomes much more tenuous. The vowel /u/ would now join /i/ as a neutral vowel, occurring with both [ATR] and non-ATR vowels.

Now, the only evidence for an [ATR] contrast falls on /ə/ ~ /a/. Many languages have these vowels in their inventories without having a contrastive feature

[ATR]. As we observed earlier, the contrast between these vowels could more straightforwardly be attributed to a difference in height. Indeed, the feature [low], which is required independently, can also serve to distinguish /ə/ from /a/.

Therefore, without assuming that the phoneme /ə/ changed phonetically, the loss of /ʊ/ could have indirectly led to a change in the phonological status of /ə/, from [low] to nonlow. This reclassification, in turn, could have influenced the phonetic realizations of /ə/, because in Spoken Manchu it is definitely a nonlow vowel. Zhao (1989) characterizes it as a mid-high back unrounded vowel, with an allophone [ɣ]; according to Ji et al. (1989), [ə] is in free variation with a high back unrounded vowel [ɯ]. It is reasonable to suppose that there is a mutual influence between phonology and phonetics in such cases. The phonetics of a vowel obviously influence its phonological representation; but this influence is not simply one way, and the phonological representation can in turn affect the phonetics, by defining the space within which the vowel can vary.

The change in status of /ə/ in turn has consequences for the specification of /u/. Recall that in Written Manchu we found evidence that the vowel /i/ is phonologically [coronal], but no evidence that the vowels /u/ and /ʊ/ are phonologically [labial], though they are phonetically round. Recall also that this lack of [labial] specification is entirely expected under the theory of contrastive specification we are assuming: because only a single place contrast exists in the nonlow vowels, that contrast can be either [coronal] or [labial], but not both.

The elevation of /ə/ to a nonlow vowel, joining /i/ and /u/, changes the situation. Assuming, as before, that [coronal] takes precedence, /i/ is again specified [coronal], distinguishing it from /ə/ and /u/. But now we must still distinguish the latter two vowels from each other. The most straightforward distinction is again a place distinction, whereby /u/ is specified [labial], as diagrammed in (19).

(19)   Spoken Manchu after loss of /ʊ/

[coronal]			[labial]
i		ə	u
		a	ɔ [low]

There is positive evidence that Spoken Manchu /u/ has acquired a [labial] specification. We cannot appeal to labial harmony, because both labial and ATR harmony have been destroyed in Spoken Manchu (Zhang 1996). However, the development of the new phonemes /ɛ/ and /y/ does provide evidence bearing on this question. According to Zhang (1996), Spoken Manchu /ɛ/ often corresponds to Written Manchu /a/ when followed by /i/. It is likely, then, that this phoneme originated from /a/ followed by /i/. Since /i/ has a [coronal] feature and /a/ has a [low] feature, it follows that the addition of the [coronal] feature from /i/ to an /a/ would result in a [low, coronal] vowel, namely /ɛ/. This development could have begun even in Written Manchu, since the features that participate in the process were all in place. Over time, however, as various other changes caused the original environment of the rule to become obscure, the vowel /ɛ/ started appearing in unpredictable contexts and became a new phoneme.

The Spoken Manchu vowel /y/ also developed from a sequence of vowels. As Zhang (1996) shows, Spoken Manchu /y/ corresponds to Written Manchu /i/ followed by /u/, as well as /u/ followed by /i/. Now, /y/ is a front round vowel and thus has the features [coronal] and [labial]. The feature [coronal] is contributed by /i/, parallel to its role in the creation of /ɛ/. But the feature [labial] must come

from /u/. In Written Manchu, we have argued that this vowel did not possess a [labial] feature, but that in Spoken Manchu, following the elevation of /ə/ to a nonlow vowel, it does. The creation of /y/ thus provides evidence for the [labial] specification of /u/ in Spoken Manchu.

Like /ɛ/, the new vowel /y/ came to stand in environments where it could not simply be analyzed as deriving from /i/ and /u/, and thus became a separate phoneme which does not depend on receiving a [labial] specification from /u/. However, the development of [y] in the first place provides evidence for a labial feature on /u/.

We have seen, then, that the vowel systems of Written Manchu and Spoken Manchu act as expected given our theory of contrastive specification. Further evidence supporting this approach comes from Xibe (Sibo), another descendent of Written Manchu. The development of the Xibe vowel system is similar to that of Spoken Manchu: the contrast between /u/ and /ʊ/ has been lost along with the feature [ATR], the vowel /ə/ has been reinterpreted as a nonlow vowel, and new phonemes /y/ and /ɛ/ have developed from combinations of other vowels. As in Spoken Manchu, the development of these new phonemes supports the theory that /u/ has acquired a [labial] specification. In addition, a third new vowel, /œ/, has arisen, most likely from earlier /ɔ/ followed by /i/ (Zhang 1996:126).

Unlike Spoken Manchu, Xibe retains a labial harmony rule. According to Li and Zhong (1986), there is an alternation between /ə/ and /u/ in Xibe suffixes (this alternation is not found in Norman 1974). /u/ occurs if the stem-final vowel is round (20a), /ə/ occurs otherwise (20b).

(20)　　Alternation between /ə/ and /u/ in Xibe suffixes

	Written Manchu	*Xibe*	*Gloss*
a.	bu-hə	bu-xu	'gave'
	bɔdɔ-χɔ	bɔdu-χu	'thought'
	hətu-kən	xətu-kun	'somewhat stocky'
	farχʊ-qan	farχu-qun	'somewhat dark'
	fɔχɔlɔ-qɔn	fœχulu-qun	'somewhat short'
b.	gətə-hə	gətə-xə	'awoke'
	ana-χa	anə-χə	'pushed'
	nətṣi-kən	nətçi-kən	'somewhat flat'
	amba-qan	am-qən	'somewhat big'

Recall that in Written Manchu labial harmony was restricted to the low vowels, and created an alternation between /a/ and /ɔ/. In Xibe, noninitial vowels tended to be raised – almost always in suffixes, frequently in stem vowels – so an original sequence of the form /a/ - /a/ would become /a/ - /ə/ or /ə/ - /ə/, and a sequence of the form /ɔ/ - /ɔ/ would become /ɔ/ - /u/ or /u/ - /u/. The labial harmony observed in Xibe is not merely a holdover of Written Manchu labial harmony, however, for in Xibe harmony is triggered not only by /u/ derived from older /ɔ/, but also by original /u/. The fact that /u/ triggers and undergoes labial harmony further supports the hypothesis that it has a [labial] specification in Xibe.

5.　Conclusion
We have argued that an approach to contrastive specification in terms of the contrastive hierarchy provides an illuminating account of the vowel system of Written Manchu, and of the evolution of the later Manchu languages. In this approach, features are specified following the Successive Division Algorithm and a

hierarchy of features. In Manchu, the hierarchy has the feature [low] at the top, followed by [coronal], then [labial], and finally [ATR] at the bottom. The analysis also illustrates the subtle interplay between phonetics and phonological contrast.

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