XINKAN VOWEL HARMONY: THEORETICAL IMPLICATIONS[i]

Abstract: This paper explores Xinkan vowel harmony by describing the harmonic distribution of vowels in words and across morpheme boundaries. This discussion is then related to some typological generalizations of vowel harmony, drawing on information in five other languages. These generalizations reveal many characteristics held in common with the Xinkan system, but also several that are divergent. The typologically uncommon nature of the Xinkan vowel harmony system, furthermore, adds to two theoretical concepts used in the explanation of vowel harmony systems. First, it shows a need to differentiate between vowels and articulatory features which trigger harmonic assimilation. Second, the features triggering assimilation can be classified as either weak or strong depending on their ability to induce assimilation across morpheme boundaries. Lastly, possibly two types of harmonic assimilation are required (partial and total), and the Xinkan system falls in between these two extremes.

[Keywords: Xinka, vowel harmony, Guatemalan languages, phonology, harmonic triggers]

1. Introduction

This paper has three goals, (1) to describe the vowel harmony patterns in Xinkan languages, (2) to relate those patterns to other vowel harmony languages, and (3) to show the theoretical implications of the Xinkan system. The theoretical implications discussed in this paper focus on the suggested universal tendencies of height harmony systems and on two dichotomies of harmonic triggers discussed in the literature: strong/weak triggers and total/partial feature spreading. It is claimed that the Xinkan system is unusual because of the patterning found among the high vowels *i, u,* and, *ɨ.*

Xinkan is a small language family located in southeastern Guatemala which has no known genetic affinities. Four languages are considered members of this family: Guazacapán, Jumaytepeque, Chiquimulilla, and Yupiltepeque. In Lehmann (1920) two other varieties, Jutiapa Xinka and Sinacantán Xinka, were also added to the Xinkan family. While the status of these latter now extinct entities has not been investigated in detail, it has been proposed that these are probably dialects which should be grouped with Yupiltepeque as the same language (** p.c.)[ii]. Yupiltepeque and Chiquimulilla are also now extinct. Jumaytepeque has one surviving native speaker who is in his nineties and two rememberers of the language in their eighties. Guazacapán has two semi-speakers, and four rememberers, all over eighty.

This paper focuses on the vowel harmony patterns of Guazacapán Xinka; however, the same patterns are found in the other Xinkan languages. In section two the vowel inventory of Guazacapán Xinka is surveyed. Since vowel harmony systems by definition require unique distributional patterns for certain classes or groups of vowels in words, a description of the distributional patterns of each vowel in lexically stipulated roots and across morpheme boundaries is also given. In section 3, two important concepts in vowel harmony systems, transparency and opacity, are discussed showing how these concepts relate to the Xinkan system. Finally, in section 4 the two theoretical approaches of strong/weak triggers and partial/non-partial feature spreading are applied to the vowel harmony system in Xinkan.

2. Xinkan Vowels and Vowel Distribution

There are twelve oral vowels in Guazacapán consisting of *i, e, a, o, u,* and *ɨ* (high central unrounded vowel), with both long and short contrasts for each vowel. The length contrast in the vowel inventory plays no significant role in the vowel harmony system, both long and short vowels follow the same harmonic patterns. The majority of examples given in this section contain short vowels, though this should not be seen as a bias but rather as an artifact of the data selected for illustration. Long vowels are included wherever possible. The vowels with their articulatory feature specifications are given in (1).

(1) Guazacapán vowels

/i/ and /ii/ - high front unrounded

/ɨ/ and /ɨɨ/ - high central unrounded

/u/ and /uu/ - high back rounded

/e/ and /ee/ - mid front unrounded

/o/ and /oo/ - mid back unrounded

/a/ and /aa/ - low central unrounded

A defining attribute of vowel harmony is a restriction on which of the vowels are permitted to pattern together in optimally formed words. Traditionally these limitations are thought to form classes or sets of vowels (i.e. harmonic sets) that are based on one or more articulatory features found in the inventory. For this reason it is important to understand the natural classes of vowels in a language with vowel harmony. It is widely assumed that these natural classes are dependent on the system's articulatory features and form the basis for the harmonic sets.

Based on the articulatory featural definitions in (1) above, the Xinkan vowel inventory can be separated into three front/back distinctions (front, central, and back) and three high/low distinctions (high, mid, and low). Usually it is assumed that the articulatory features of a phonetic segment and the distinctive feature analysis of that segment are closely associated with one another. This is specifically relevant because the vowel harmony systems described in other languages often rely on distinctive features to motivate the harmonic classes of vowels. Importantly, however, a traditional distinctive feature analysis of this vowel system would allow only a single front/back distinction: front vs. back vowels (Pullman and Ladusaw 1986). In this analysis, /ɨ/ and /a/ share the feature [+back] with both /u/ and /o/ (though this feature analysis is questioned below). This is at issue specifically because the Xinkan vowel harmony system is problematic for approaches to harmony which are based on these distinctive features. The distinctive feature analysis of the six short vowels is provided in (2).

(2) Distinctive Features of Guazacapán Vowels:

/i/ - [+high][-low][-back][-round]

/e/ - [-high][-low][-back][-round]

/u/ - [+high][-low][+back][+round]

/o/ - [-high][-low][+back][+round]

/ɨ/ - [+high][-low][+back][-round]

/a/ - [-high][+low][+back][-round]

This featural analysis provides for particular natural classes in this vowel inventory: high vowels [+high], mid vowels [-high][-low], low vowels [+low], front vowels [-back], back round vowels [+back][+round], and back non-round vowels [+back][-round]. Vowel harmony in different languages can make use of one or all of these distinctions. This traditional analysis proves to be problematic in the Xinkan system, however, because the language makes use of the three-way articulatory classification of the front, central, and back vowels for the high vowels, but not for any vowels of any other height.

This classification is in addition to that of the high, mid, and low vowels. That is, though the Xinkan vowel inventory can be divided into traditionally defined natural classes, it phonologically makes use of classes that might be considered disjunctive in the classification in (2) by separating the distribution of the high front vowel and high back rounded vowel into one class and the high central unrounded vowel (designated as "[+back][-round]" in traditional distinctive features) into another. Thus it needs a front class, a central class, and a back class of vowels for vowels with the feature [+high]. It might be argued that the [round] feature of the back vowels is extremely important in determining vowel patterns, and this may be part of the right analysis. However, the fact that the low vowel /a/ patterns differently from /ɨ/ though they are members of a natural class with features [+back][-round] argues against this classification for the Xinkan system. This means that the harmonic sets in Xinkan cannot be represented in a revealing way with the distinctive features in common use.   An explanation of the distribution of the vowels further indicates how the harmonic sets are formed.

The distributional patterns of the vowels in a word in Xinkan are lexically stipulated and apply to all words without exception or recourse to their grammatical class or function. The distribution of two of the high vowels /i/ and /u/ can occur together in a word and with /a/, but crucially cannot co-occur with any other vowel in the inventory. Examples of this are given in (3).

(3) Distribution of /i/ and /u/ in roots:

hiiru	'monkey'
tułtu	'stab/poke'
ts'il'i	'make smooth'
čiiri'	'short'
ts'uułi	'ladino'
miya	'hen'
tum'ay'	'tail'
ts'am'u	'close your eyes'
pari	'day'

The high vowel /ɨ/ does not occur in this list because it patterns differently, as mentioned above and explained in (4) below. Three things can be observed from the words in (3). First, that the high vowels *i* and *u* can occur with one another, but not with /ɨ/. That is, /i/ and /u/ form a set of vowels that can co-occur freely with each other but /ɨ/ is excluded from that set. Second, the set {i, u} can co-occur with the low vowel /a/. This suggests that these three vowels group together as a single harmonic set, {i, u, a} (this set will be modified significantly below). Third, the linear order of the vowels in a word is not important as each of the vowels in this class can occur in any position in relation to the other vowels of the set (e.g. i-u, u-i, i-a, u-a, a-i, and a-u; i-u-a, i-a-u, a-i-u, a-u-i, u-i-a, u-a-i, etc.).

This harmonic set would have been consistent with the natural class of high vowels proposed by the articulatory features in (2) above if /ɨ/ had formed part of the set. The fact that it does not, indicates at least preliminarily, that the harmonic system in Xinkan is not merely a height vowel harmony system (as will be seen below), but also relies on an additional feature or features (i.e. [round] and [back]). The distribution of /ɨ/ is such that it only co-occur with other instances of /ɨ/ or with /a/; examples are given in (4).

(4) Distribution of /ɨ/ in roots:

pɨk'ɨ	'liver'
ts'ɨɨrɨɨrɨ'	'gorion'
ts'ɨɨm'aɬ	'flea'
waw'ɨya	'run' (water)

These examples also show three distribution properties of /ɨ/, which resemble partially those observed for the harmonic set {i, u, a} given above. First, /ɨ/ can occur only with other instances of /ɨ/ or with /a/. This means that it is illegal to have a string containing /ɨ/ together with any of the vowels /i, u, e, o/. Second, /ɨ/ can occur with the low vowel /a/, just as /a/ could occur in the set {i, u, a}. This means that a second harmonic set {ɨ, a} is part of the vowel harmony system in Guazacapán. This raises a problem for the definition of the {i, u, a} set, since /a/ can co-occur with vowels of both of these mutually exclusive sets. It occurs freely with any high vowel while the high vowels themselves are restricted distributionally; /ɨ/ is not able to combine with /i/ or /u/. This would seem to be counter-intuitive, where one vowel seems to belong to two otherwise mutually exclusive classes. The last pattern of distribution for /ɨ/ is that there is not a restriction on the linear order of the segments of the set {ɨ, a} (e.g. /ɨ…a/ and /a…ɨ/).

The observed patterns of distribution for the low vowel /a/ require an explanation, but before a complete characterization of /a/ can be given which will satisfy the competing observations above, the distribution of the mid vowels needs to be given. The distribution of these vowels is presented in (5).

(5) Distribution of /e/ and /o/ in roots:

ṣ̌eek'e	'chest'
ter'o	'want/die'
ts'oko	'grackle'
k'oosek	'large'
seema	'fish'
goona	'hill'

Mid vowels occur with less frequency in the Xinkan lexicon than the other vowels; however, the words in (5) show that the mid vowels /e/ and /o/ have similar distributional patterns to those that have been described for the high vowels. However, importantly, the linear order of the mid vowels is restricted. Specifically, two generalizations are observable in the data: first, the mid vowels /e/ and /o/ form a harmonic set where both members of the set can co-occur freely with each other in any linear order. Second this mid vowel set {e, o} can also co-occur with the low vowel /a/ giving the harmonic set {e, o, a}. This means that /a/ cross-cuts all three harmonic sets observed ({i,u}, {ɨ}, and {e,o}) and must be allowed to pattern with each of them. However, the difference between the mid vowel set {e, o} and the other two sets {i, u} and {ɨ}, lies in the restrictions on the linear order of the sets with the low vowel /a/. Specifically, there are no examples anywhere else in the data where /a/ precedes /e/ or /o/ in a native Xinkan morpheme (that is /e…a/ and /o…a/ are permitted but /a…e/ and /o…a/ are not). In order to provide a more complete picture, however, it should be noted that a mid vowel can follow the low vowel in loan words as in (6).

(6) Distribution of /e/, /o/ and /a/ in Loan Words:

adoobe ‘adobe’ (Spanish adobe)

paale’ ‘priest’ (Spanish padre)

This linear order of vowels in loan words is similar to that for the other vowel sets {i, u} and {e, o}. The patterns exhibited in loan words, however, are not considered part of the distribution of the Xinkan vowels into the sets being described here, as they are borrowed from a language without similar harmonic constraints.

The foregoing discussion of the distributional patterns observable in Xinkan divides its vowel inventory into three harmonic sets; a high set excluding /ɨ/:{i, u}; a mid set: {e, o}; and a set containing only one vowel: {ɨ}, with /a/ as a neutral vowel that can co-occur with any of the three sets. The vowels in the first two harmonic sets have the same articulatory features as given in (2) above except for the feature [high]: {i, u} are [+high] and {e, o} are [-high]. That is, the set {i, u} is [+high] while the set {e, o}is [-high]. The {ɨ} set is also [+high] and therefore can easily be distinguished from the {e, o} set by the [high] feature; however, it cannot be distinguished in a natural way from the {i, u} set, by any one single feature in the distinctive features framework despite the need to do so made obvious by the distributional patterns given above. It might be characterized, awkwardly, as the [+high][+back][-round] set. An appropriate way to distinguish the {i, u} set from the {ɨ} set may be found only in the number of features of a vowel that are required to participate in harmony. Crucially both the features [back] and the feature [round] are necessary to distinguish {ɨ] from {i, u}, a very unique natural class indeed.

In addition to these three harmonic sets of vowels, a more precise description of /a/ follows from the patterns given above. One possible characterization of this vowel, as viewed in some approaches, is that it might be considered a member of each set though with allophonic variation corresponding to that set's specification for the feature [high] (e.g a slightly higher realization of /a/ when it co-occurs with vowels in set I and set III than with those of set II). This would allow this vowel to be part of every vowel set phonetically (see Gick et al 2006). If this could be substantiated, this analysis would support work on sub-phonemic variations in vowel harmony languages in Gick et al (2006) and Benus and Gafos (2007). However, one obvious problem with this analysis is that it weakens the claim that set I and set II are divided according to differing values of the feature [high]. That is, if one member of the set {i, u, a} only differs phonetically from the set {e, o, a} and not categorically in terms of the feature [high] then it would follow that the two sets are disjunctive and somehow not completely categorical. Specifically two of the three members of each set would be categorically (i.e. phonemically) distinct for [high] while the third member of the set would only be distinct on a relative continuum (i.e. phonetically) based on the articulations of the other members in the set. This would mean that the /a/ in the set {i, u, a} would only be relatively higher than the /a/ in the set {e, o, a} and would threaten the *categorical* division of vowels into harmonic sets.

Similarly, the proposal for a sub-phonemic difference in the low vowel would argue that there should be a variant that is round and one that is not round to distinguish set I from set III.This assumption might prove to be problematic for the description of Xinkan vowel harmony, because either the low vowel would need to have a non-round high alternation and satisfy /i/ and /ɨ/, or have a round and high alternation and satisfy /u/. This would mean that the low vowel alternations do not obey the harmonic patterning of vowels because there would be no alternation that would satisfy all harmonic sets equally.

A second, more elegant, description is found if /a/ is not considered part of any of the three sets observed in Guazacapán Xinkan. In this description the relative height of /a/ is irrelevant. What is relevant in this description of the low vowel is that it is impervious to the systematic constraints on which vowels can occur together and that any variations are based solely on the phonetic constraints on the word (e.g. ease of articulation). In this sense /a/ is considered a neutral vowel, meaning that it does not participate in the division of the vowel inventory into harmonic sets. This is consistent with many other vowel harmony languages where often one or more vowels are not required to participate in the harmonic spreading of a feature (Kramer 2003). This description furthermore eliminates the difficulties in finding a feature (or another reason) to account for the harmonic sets in Xinkan. The inventory can simply be divided into the three harmonic sets {i, u}, {e, o}, and {ɨ} and the neutral vowel {a} instead of the sets {i, u, a}, {e, o, a}, and {ɨ, a}.

Just as there are constraints on what vowels can occur together in the root (i.e. a lexically stipulated string), there are also constraints on which vowels can occur cross morpheme boundaries[iii]. These patterns follow those discussed for the roots, except that the constraints on legal strings are less stringent. Specifically, what has been called the {ɨ} set appears to conflate with the {i, u} set, while the {e, o} set remains distinct. This difference in harmonic vowel sets can clearly be seen when the plural suffix /-łi/ is attached to the root[iv]. The patterns are given in (7).

(7) Harmony in Stems:

hiiruu-łi

monkey-PL

'monkeys'

ts'okoo-łe

grackle-PL

'grackles'

pɨk'ɨɨ-łi

liver-PL

'livers'

paalee-łe

priest-PL

'priests' (from Spanish 'padre')

These examples show that the plural morpheme has two allomorphs, the realization of which depends on the vowel(s) in the root. If the vowels are specified with the feature [+high] then the vowel in the suffix is also required to be [+high], being realized as [-łi]. However, if the vowels in the root are specified with the feature [-high], the vowel in the suffix is required to agree with his specification and is realized as [-ɨe]. This same pattern is also true for loan words as shown in the example of *paaleeɨe* ‘priests’ in (7).

Furthermore, in terms of feature theory it might be assumed from these examples that the [high] feature of the root vowel(s) is spreading to the plural suffix for all three harmonic sets, or at least for the mid vowels. Interestingly, however, the {ɨ} set does not occur only with other instantiations of this same vowel as it does in lexically stipulated roots. That is, in a lexically stipulated root, vowels in any word containing {ɨ} are required to have completely identical specifications for all articulatory features (i.e. they are identical) except for /a/; whereas, across morpheme boundaries only the specification of the feature [high] is to be the same for all vowels. This points to the need for feature characteristics that propagate harmony rather than the features themselves and is taken up in section 4.

One last characteristic of vowels in Xinkan is important to complete the description of their distributional patterns: the characterization of the neutral vowel /a/ across morphological boundaries. That is, it is important to discuss the function of the low vowel /a/ when it intercedes when the [high] feature is expected to cross a morpheme boundary. These patterns are given in (8).

(8) Harmony involving /a/ across morpheme boundaries:
miyaa-ɨi

chicken-PL

‘chickens’

tum’aa-ɨi

animal-PL

'animals'

seemaa-łi

fish-PL

'fishes'

k'oots'ay-łi

ant-PL

'ants'

kɨşǎa-łi

bat-PL

'bats'

In the discussion of vowel distribution in both roots and stems it was observed that /a/ did not participate in dividing the vowel inventory into mutually exclusive harmonic sets and that it should be considered neutral. This leaves the characteristics of this vowel undefined in terms of its function, or importance, in the overall vowel inventory. In the examples in (8) it is observed that when a root ends in /a/ preceded by the vowels in the {i, u} set, the {e, o} set, or the {ɨ} set and a suffix is attached to the root, the vowel in the suffix is always realized as [+high], thus arguing in favor of the assumed underlying form /-łi/ of the plural morpheme. For two of the sets {i, u} and {ɨ] this is not surprising as it was observed that the vowel in the suffix is always realized as [+high] due to harmonic rules. However, for the {e, o} set this pattern seems to contradict the observations in (7) where the suffix was shown to be realized as [-high] following these vowels. The most ready solution to this apparent contradiction is found in the definition given that /a/ is neutral. Neutral vowels have traditionally been sub-divided into either transparent or opaque vowels, and in Xinkan it seems that this characterization may also be applicable. Specifically, the neutral vowel /a/ acts transparently and/or opaquely depending on the phonological environment in which it is found. Section three surveys these characteristics more fully.

3. Transparency and Opacity[v]

Kramer (2003:27) says that "opaque vowels resist assimilation, [and] start a new harmonic domain with their own feature specification." Application of this principle in the Xinkan system means that an opaque vowel is not required to have identical featural specifications as the vowel preceding it and that any vowels following the opaque vowel will start assimilation of vowel features anew. This is exemplified in example (9).

(9) $CV_{f_1}CV_{f_1}CV_{f_2}CV_{f_3}CV_{f_3}$

The feature specification of the first vowel in (9) 'triggers' assimilation of every subsequent vowel to an identical featural specification for some feature [f], which is indicated by the identical [f1] values on both of the first two vowels. This type of feature assimilation is seen in (7) above where all three sets of vowels require the suffix to have an identical specification for [high]. However, in (9), the triggering of feature assimilation is stopped when it reaches the third vowel in the string. This is the opaque vowel, which has a unique specification for the feature [f]. The vowel following the opaque vowel in (9) (i.e. the fourth in the string 'CV_{f_3}') begins to trigger featural assimilation in subsequent vowels according to its own value for [f]. Thus, the last two vowels have identical specifications for feature [f], which are crucially different from the specification on the first two vowels. This pattern can be observed in (8) above in words like *seemaaɬi* 'fishes'.

Kramer (2003:28) defines a transparent vowel as “one that is immune to assimilation as well, but instead of initiating its own harmonic domain to one side, the vowel lets the harmonic feature specification ‘pass through’ from one side and affect the vowel to its other side”. For Xinkan this means that vowels in transparent environments (i.e. vowels on either side of a transparent vowel) will have identical specifications for [high], but that the transparent vowel is not required to have this same specification. Transparency is shown in example (10).

(10) $CV_{f_1}CV_{f_1}CV_{f_2}CV_{f_1}CV_{f_1}$

Similarly to opaque vowels, the specification of the feature [f] of the first vowel ‘triggers’ assimilation of every subsequent vowel to an identical feature value for this feature. The triggering of feature assimilation is again stopped when it reaches the third vowel in the string. This is the transparent vowel, which has a unique specification for the feature [f]. Different from opacity, however, the vowel following the transparent vowel (i.e. the fourth in the string) is “targeted” by the first vowel and is required to continue the assimilation sequence of the value for [f] as if the transparent vowel had not intervened. Every vowel thereafter is similarly required to participate in harmony. Thus the last two vowels have an identical specification for feature [f] to that of the first vowel. This pattern can also be observed in (8) above in words like *miyaaɬi* ‘chickens’.

Although these descriptions are adequate for characterizing what has traditionally been referred to as the functions of a neutral vowel, there is one major drawback: it does not capture any unifying generalization between opacity and transparency, which Benus and Gafos (2007:293) argue exists. They do provide this unifying generalization when they discuss contextual dependency of transparency and opacity. They write that “transparency is not a categorical property of vowels but it is determined contextually. The same vowel can be transparent in one context and opaque in another." This means that transparency and opacity are two sides of the same coin. In Xinkan this observation is directly relevant because only one vowel /a/ is not required to agree with the feature specification of [high] for the three harmonic sets. More specifically, when /a/ occurs with vowels in the {i, u} set and in the {ɨ} set, it can be characterized as transparent, but when it occurs with vowels in the {e, o} set, it can be characterized as opaque.

This contextually dependent classification of neutral vowels, however, may not be ideal for all harmonic languages. It necessarily raises the question whether vowels are truly neutral and behave opaquely or whether they are transparent. In Xinkan for example, the neutral vowel might better be considered opaque always and due to the underlying phonetic shape of the plural morpheme it just appears as if it were acting transparently[vi]. At least two recent studies have addressed this issue cross-linguistically and have attempted to find phonetic characterizations of the so-called neutral vowels. For example, Gick et al (2006) show that acoustically a neutral vowel does participate in the [ATR] harmony of Kinande. The neutral vowel /a/ was shown to have a tense counterpart /ə/ when placed in a harmonic domain where it was surrounded by tense vowels. Similarly, Benus and Gafos (2007:272) show that on a sub-phonemic level the transparent vowels in Hungarian also participate in [back] harmony. They argue that in Hungarian, "transparent vowels…are those vowels which can be articulatorily retracted to a certain degree while maintaining their front perceptual quality". One of the things these two acoustic studies have in common is that they show that so-called transparent vowels are most likely not transparent at all, meaning that the notion of transparency is in need of refinement.

However, things might be different for Xinkan because the neutral vowel is better classified as opaque. In Hungarian the transparent vowel /i/ is said to be realized as [> back] (where the symbol '>' means 'more…than' contextually independent realizations) and in Kinande /a/ can become [> tense] and retain their perceptual distinctiveness. However, in Xinkan it is questionable whether the low central vowel /a/ can have a corresponding variant that has the feature [> high] and still be perceived as a low vowel. A pilot study was conducted on the word lists and stories collected in Kaufman and Campbell (1977) to study whether the neutral vowel in Guazacapán Xinkan participated in harmony acoustically. The results of that study are briefly surveyed below, (but see forthcoming work for a more thorough discussion of the neutral vowel).

Vowel mid-points for the neutral vowel /a/ were measured in the three different posited harmonic contexts: transparency, opacity, and no harmony. The mid-point values were measured for F1, F2, and F3. These measurements were made across 66 words in 22 recorded texts. An ANOVA was performed to see if there was significant statistical difference in the neutral vowel mid-points in the three contexts. A statistical difference would indicate that the neutral vowel is participating in vowel harmony acoustically. The ANOVA showed no statistically significant differences in the format values of /a/ across any of the harmony contexts. This initial finding provides support for the claim that the neutral vowel does not undergo harmony acoustically and is strictly non-local (i.e. long-distance assimilation). Thus, as indicated above, the neutral vowel in Xinkan might better be classified as only opaque because it does not have any transparent variations at a phonetic level. Furthermore, arguing against a universal implication of allophonic variation of neutral vowels dependent on phonetic context.

4. Discussion

The forgoing description of Xinkan vowel harmony shows that these languages have vowel harmony which is predominantly based on the articulatory feature [high]. This means that inside the harmonizing strings all vowels are to have identical values of this feature, except neutral /a/.

Kramer (2003) refers to the environment that allows vowel harmony as the “harmony domain”. However, in Xinkan it has been shown that there are two harmony domains with different harmonic patterns; the first refers to vowels in a lexically stipulated root and the second to vowels across morpheme boundaries. These two domains place similar requirements on vowels with the only exception being that the vowel in the {ɨ} set behaves differently in each. This section discusses the typological profile of the Xinkan vowel harmony system and possible explanations for the patterns of this vowel.

In the root domain, or lexically stipulated word, the vowels are divided up into three sets, {i, u}, {e, o}, and {ɨ}. In the stem domain, which includes suffixes, the vowels are divided up into two sets, {i, u,ɨ} and {e, o}. It was also shown that there was one neutral vowel {a} which may be characterized as opaque because of its effects on the spread of harmony throughout the domain. These patterns can be depicted as in Table 1.

Table 1 Vowel Harmony Sets

	Front		Back	
High	i	ɨ	u	Set I
	e		o	Set II
Low		a		Neutral

Set III

The circles around the vowels represent the harmonic sets and indicate that the {ɨ} set is both its own set and part of the {i, u} set depending on context. This fact, that Xinkan has two harmony domains and up to three harmonic sets, is uncommon among vowel harmony languages, where most languages have one harmony domain and most commonly only two harmonic sets. As shown below comparison of some of the languages reveals the typological significance of the Xinkan system.

Vowel harmony can be defined cross-linguistically as, "the phenomenon where potentially all vowels in adjacent moras or syllables within a domain like the phonological or morphological word (or a smaller morphological domain) systematically agree with each other with regard to one or more articulatory features" (Kramer 2003:3). This definition is good because it highlights three essential characteristics of vowel harmony: the domain, the number of articulatory features involved, and adjacency. Aiding cross-linguistic comparison of vowel harmony is recognition of each of these three requirements in any given vowel harmony language. Here, five languages (Finnish, Turkish, Yoruba, Futankoore Pulaar, and Shona) are examined in terms of these characteristics (the data for these five languages is taken from the descriptions found in Kramer (2003) (see this source for primary data and more information).

Finnish has been described as having [back] vowel harmony. That is, the vowel inventory of Finnish is divided into harmonic sets according to the specification of the articulatory feature [back]. Front vowels co-occur only with other front vowels and back vowels co-occur only with other back vowels. Additionally, two Finnish vowels, /i/ and /e/, are considered transparent because they allow harmony to 'pass through' and their feature specifications remain unaltered. The eight vowels in the system of Finnish can then be described as either part of the back vowel set {a, u, o,}, part of the front vowel set {ä, æ, y, ö}, or as a neutral vowel {i, e}. Harmony crosses morpheme boundaries and applies to the language's suffixes within the domain of the prosodic word. Finnish thus has one harmony domain and two harmonic sets.[vii]

Turkish also has a dual vowel harmony system based on the feature [back] as well as on the articulatory feature [round]. The eight vowels in the Turkish inventory are either front or back. The front vowels form a harmonic set {i, y, e, o̎} and the back vowels form another harmonic set {ɨ, a, o, u}. Vowels can only co-occur with other vowels in the set to which they belong. Additionally, high vowels are divided into harmonic sets in terms of the feature [round]. In other words /e, ö, o, a/ do not participate in [round] harmony and are therefore neutral and considered opaque. These distributional constraints on vowels occur within the clitic group. Importantly, then, Turkish has one harmony domain and two harmonic sets for each of the features [back] and [round].

Unlike Finnish and Turkish, a number of Niger-Congo languages have vowel harmony based on the feature [ATR] (Advanced Tongue Root). For example the seven vowels in Yourba and Futankoore Pulaar are divided into those that are [+ATR], those that are [-ATR], and the neutral vowels. The [+ATR] set vowels are {e, o} and can only occur with each other. The [-ATR] set vowels are {ɛ, ɔ} which can similarly only occur with each other. There are three neutral vowels in these languages /i/, /u/, and /a/, which are not required to participate in harmony. For both of these languages the domain is the stem (i.e. across morpheme boundaries). The difference is that in Yoruba harmony applies to prefixes and in Futankoore Pulaar the harmony is triggered by the [ATR] specification of the first vowel in the suffix and is spread to the stem. This means that both of these languages have one harmony domain and two harmonic sets.

Shona, a Bantu language, is an interesting comparison due to its similarity to Xinkan vowel harmony. Shona exhibits harmony based on the feature [high] were the first vowel in a root determines the value of the feature [high] for the rest of the word, including suffixes. The vowel inventory, consisting of five vowels, is consequently divided up into two harmonic sets {i,u} and {e,o} with {a} being characterized as neutral. Harmonic constraints only apply with the domain of the lexical word. This means that Shona has two harmonic sets and one harmony domain.

These five languages have attributes of vowel harmony in common with Xinkan (especially Shona), but none of them exactly resembles the Xinkan system. Specifically, when compared to these vowel harmony systems in these five languages, Xinkan is uncommon on two grounds: it has *two* distinct harmony domains, and for one harmony domain (the lexical root) it has *three* harmonic sets. The next two sections provide possible explanation for this unique vowel harmony system in Xinkan languages.

4.1 Weak vs. Strong Triggers

Traditionally in theoretical approaches to vowel harmony the vowel causing other vowels to agree with its specification for some feature is referred to as the harmonic 'trigger'. In Xinkan, each of the vowels in the three harmonic sets act as a trigger because they require other vowels following them (except for the neutral vowel) to have identical specifications for the articulatory feature [high] or [high, [back], and [round]. As it is features that are assimilated in this approach, and not necessarily the whole vowels themselves a more accurate description of a harmonic trigger would focus on the features. That is, some articulatory feature (not the vowel itself) of a vowel in languages with vowel harmony requires assimilation to its feature specification. The Xinkan system indicates, somewhat narrowly, that features triggering assimilation may be either weak (not able to trigger across certain boundaries) or strong (able to trigger across all boundaries).

I adopt the notion of strong trigger found in Walker (2005) as harmony which "propagates through all possible syllables of the word" (p. 919). In Xinkan this means that a strong trigger will propagate the harmonic feature through all syllables in a stem including any suffixes (i.e. across morphological boundaries). I also adopt Walker's notion of weak trigger. She defines a weak trigger as harmony motivated by a "perceptual disadvantage" (p. 920). It is unclear how this term is to be specifically defined or how the vowel harmony system of Xinkan languages might show a perceptual disadvantage, but the dichotomy between weak and strong triggers is useful for an explanation for this harmonic system.

According to this strong/weak distinction, the articulatory feature [high] can be seen as a strong harmonic trigger in Xinkan, because its specification is required to be identical in all syllables of a word. This applies to vowel strings across morphological boundaries from stem to suffix. The only exception to this generalization is caused by an intervening neutral vowel, which is not required to participate in harmony. Thus the {i, u} set, the {e, o} set, and the {ɨ} set all spread their specifications for [high] to any suffixes attached. This accounts for the harmonic processes in the stem harmony domain.

However it was shown that *all* the feature specifications of all the articulatory features of the {ɨ} set are required to spread to subsequent vowels, but only within the domain of the root. The fact that this same generalization does not hold across morpheme boundaries argues that the other articulatory features of this vowel are somehow weaker than the [high] feature and are not able to spread to all syllables. The /ɨ/ vowel was shown to have the traditional distinctive feature analysis shown in (11).

(11) /ɨ/ - [+high][-low][+back][-round]

This means that in the vowel harmony system of Xinkan, the articulatory features [-low], [+back], and [-round] are weak, in that they are not required (or allowed) to spread to vowels in syllables outside the lexical root. These features seem not to have the 'harmonic strength' to propagate outside the harmony domain of the root. Whether this is due to a "perceptual disadvantage", as suggested by Walker (2005), is questionable, however, the perceptual vowel space limitations of Xinkan might show why these features are unable to spread.

Benus and Gafos (2007) point out that each vowel, in a given language's vowel inventory, is given a perceptual space. This perceptual space might be defined in terms of the articulatory features of a vowel. For example, in English, there might be a space that is defined as being perceptually /i/ (or some other vowel), based on the specifications for the features [back], [high], [tense], and [round] no matter the fine-grained phonetic characteristic of the sound.[viii] Furthermore if the production of the vowel by the speaker falls within this space it is easily perceived correctly by the hearer. However, if two vowels have overlapping perceptual spaces, perception of the difference between the two vowels will be more difficult for the hearer.

As shown in the traditional distinctive feature analysis of /u/ and /ɨ/, the perceptual space, based on their articulatory features, overlaps completely except for the feature [round]. The hearer's task to discriminate the two sounds is consequently more difficult than between the /i/, /u/ contrast. By requiring /ɨ/ to be constrained to a harmonic set all by itself, the vowel harmony system appears to make a stronger contrast between them, meaning that the perception of these two sounds as distinct may become easier. That is, because /u/ only occurs with the {i, u} set and /ɨ/ only occurs with the {ɨ} set, the language seems to have adopted a strategy that allows these two sounds to become maximally contrastive. Whether this phonologically is the case for the hearer is left open for further research.

Moreover, the weak triggers in the {ɨ} set, [-low], [-back], and [-round] do not require agreement in the suffixes because suffix vowels are either [+high], or [-high]. That is there is no contrastive perceptual distinction to be made in the suffixes over the feature [back] or [round]. There is no need for a hearer to make a contrast between /ɨ/ and /u/ outside the root.

4.2 Total vs. Partial Harmony

The behavior of /ɨ/ points to another theoretically important consequence of Xinkan vowel harmony which relates to the amount of harmony required to occur. Kramer (2003) points to the fact that there are possibly two broad types of vowel harmony systems: total and partial. Partial vowel harmony is exemplified in languages like Finnish, Turkish, Yoruba, Pulaar, and Shona described above, and consists of only a partial set (one or two) of the overall number of articulatory features triggering harmony in the harmony domain. Total vowel harmony is exemplified in languages like Yucatec Maya and Ainu (see Kramer 2003), and consists of the entire set of articulatory features of a vowel 'triggering' harmony. That is, in partial harmony only one or two articulatory features are 'copied' onto subsequent vowels, whereas in total harmony the entire set of features is.

Whether or not total harmony systems can actually be designated as vowel harmony is questionable because of two limitations. First, in both Yucatec Maya and Ainu total harmony is confined to a relationship between one vowel in the root and another in an affix. Second, the total copying of all features is not iterative. That is the harmonic sets to which this kind of harmony might apply is extremely limited, usually consisting of only one vowel per set, and the harmony domain is limited to a certain specific affix without being productive in all affixes across the language. In this regard, the vowel distribution in Yucatec Maya and Ainu is most likely a case of phonological reduplication, or copying, rather than vowel harmony.

However, as shown in Xinkan, these limitations are not as strongly enforced. That is while the {ɨ} set consists of only a single vowel with weak harmonic triggers, the pattern is iterative throughout the entire language. It is not confined to handful of idiosyncratic morphemes. Vowel harmony systems can then be grouped to those undergoing partial assimilation (one or more features but not all like Finnish) and total assimilation (copying of the complete set of vocalic features like the {ɨ} in of Xinkan).

Because Xinkan vowel harmony can be analyzed as the assimilation of a single feature for the {i, u} set and the {e, o} set and possibly assimilation of all the features in the {ɨ} inside a root, the language could be viewed as a system mid way between the two types of vowel harmony given above, or as a mixed system. If these two types of vowel harmony systems are viewed as a continuum with partial assimilation on one side and total assimilation on the other, then the vowel harmony of the Xinkan languages might fall somewhere in between them as in Figure 1.

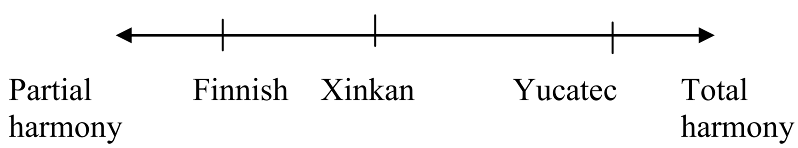

Figure 1. Vowel Harmony Types

5. Conclusions

This paper has had the goal of describing Xinkan vowel harmony and relating it typologically and theoretically to other languages. It has been shown that the vowel harmony system of this language exhibits two kinds of patterning, one lexically stipulated and the other productive across morphological boundaries. For the lexically stipulated harmony, three harmonic sets are seen to be in operation: {i, u}, {e, o}, and {ɨ}. The other pattern found across morpheme boundaries occurs when root vowels affect the height specification of a suffix vowel. In this kind of harmony the distinction between {i, u} and {ɨ} is neutralized. Additionally, in this pattern the low-central vowel is neutral can should be characterized as opaque when occurring with all three harmonic sets.

It was suggested that these patterns hold due to the nature of the harmonic triggers. The articulatory feature [high] was shown to be a strong trigger because it propagates harmony through all syllables of a word. In contrast the features [-low], [-back], and [-round] of the {ɨ} set were shown to be weak triggers because they only propagate harmony in roots and not across morpheme boundaries. It was argued that this might hold due to the perceptual difficulty in contrasting /u/ and /ɨ/. These findings point to the unique nature of the vowel harmony system of Xinkan.

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[i] The data used in this paper come from Kaufman and Campbell (1977). The work represented in this paper was supported ***.

[ii] There is much less extant data on Sinacantán Xinkan than there is on Jutiapa Xinkan.

[iii] For the most part, vowels of prefixes do not change to harmonize. The character of harmony in prefixes is presented only to complete the picture. In prefixes occasionally set {ɨ} causes harmony as in the examples given.

uy	‘water’
ɨn-ʔuy/in-ʔuy	‘my quantity of water’

1SG-water

pɨk'ɨ 'liver'

mu-pɨk'ɨ/mɨ-pɨk'ɨ 'his/her liver'

3SG-liver

This optional variation was observed for only one speaker. This, then, is probably more a matter of individual variation than language patterning. The fact that few remaining speakers are competent in the language, and that the only surviving native speakers have few opportunities to use their language, may point to the fact the harmonic agreement in prefixes may be an instance of imperfect learning.

[iv] It is assumed, due to the lack of any evidence to the contrary, that the underlying from of the plural morpheme is /-ɬi/.

[v] Only transparency and opacity in progressive (i.e. left to right) harmony is discussed, but the concept is the same for regressive harmony (i.e. right to left) as well.

[vi] I am indebted to *** for pointing this out to me.

[vii] Occasionally Finnish vowel harmony applies also across word boundaries, but only in rare situations irrelevant to the discussion here (see Campbell 1980).

[viii] See Ladefoged (1957) for a similar discussion.