Phonemic Patterns and Phonetic Characteristics of Glottalized Consonants: A Typological Perspective

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Abstract: Glottalized consonants have been the subject of research since at least the beginning of the 20th century (Sapir 1938). This research has culminated in the discovery of a number of typological patterns in both the segment inventories of languages with glottalized consonants, and in the acoustic phonetics of these consonants. However, these patterns are not able to account for general language patterns when they are applied to languages (or language families) not usually included in these cross-linguistic comparisons. This paper uses data from the languages of a small, relatively unknown, language family, Xinkan of Guatemala -- to show that the patterns associated with glottalized consonants cannot be considered general language patterns because they are developed using improper methods which threaten both their internal and external validity.

[Keywords: Phonology, Typology, Glottalized Consonants, Xinkan, Phonetics]

1. Introduction

The goal of this paper is to discuss the validity of the cross-linguistic generalizations of glottalized consonants with respect to Xinkan, a small language family in southeastern Guatemala. The purpose of this study is to discuss the usefulness and adequacy of these generalizations as tools of prediction for the sound patterns in use in the world's languages. However, the discussion in the paper emphasizes the fact that at present these generalizations have very little power of prediction (explanation) because they are based on a sample set of languages that is neither internally nor externally valid. This means that the generalizations discussed concerning glottalized consonants do not hold for all the languages in the sample set or for 'new' languages that were not included in the sample set. Following from this the goals of this paper are (1) to survey the consonant inventory of Xinkan, (2) to indicate how this inventory does not coincide with the typological generalizations and universal claims for glottalized consonants, and (3) to give reasons for the discrepancies.

Cross-linguistic comparisons of languages have the potential of revealing general language possibilities and patterns; however, the validity of these comparisons depends largely on the adequacy of the languages sampled for the comparison. A sample of languages that are genetically or areally related often may reveal interesting patterns but these cannot be generalized to languages outside the family or the linguistic area (see Comrie 1989: 5-11). In the event that cross-linguistic tendencies are unable to be generalized to 'new' languages, it must be concluded that the findings are not externally valid, and have only a weak power of prediction of language patterns.

Similarly, if the methods employed in the comparison are faulty the findings are internally invalid. For example, though patterns are recognized in a set of data those patterns are unlikely to hold in general, unless the data are controlled and consistent. That is, cross-linguistic comparisons are only generalizable to language in general if the sampling is controlled adequately for genetic and areal affiliation, and are made following appropriate methods. This paper shows that these guidelines have not been adhered to in making generalizations about glottalized consonants and therefore they cannot properly predict / explain a language's individual sound patterns.

It will be useful, before surveying the patterns discussed in the literature, to provide some definitions of the types of consonants being discussed in this paper. Glottalized consonants have been divided traditionally into three types, which Maddieson (2005) refers to as implosives, ejectives, and glottalized resonants. While these three types of consonants are all very similar, they consistently pattern differently, phonologically, in the world's languages (see Maddieson 1984: 98-122). A brief description of each is provided here to highlight these differences.

Glottalized resonants (or sonorants) are a series of consonants which includes glottalized nasals, laterals, and glides (approximants). They are traditionally characterized phonetically as being pre-glottalized, meaning that the closure and release of the glottal gesture is before the onset of any non-laryngeal phonetic trait. However, Howe and Pulleyblank (2000:49), in citing Plauché (1998) and Plauché et al (1998), indicate that for some languages "glottalized sonorants are preglottalized in onset position but postglottalized in coda position". Howe and Pulleyblank further indicate that there is a continuum of timing between those languages in which these consonants are strictly pre-glottalized on the one hand, and those that are post-glottalized on the other. This continuum predicts that languages can have any amount of mixture of the two timings as part of their acoustic characteristics of these sounds (see also Bird et al. 2008 for a relevant discussion).

Ejective consonants are segments whose articulation process is understood well. They are characterized phonetically as a compression of the air in the oral cavity causing a change of air pressure. This change in air pressure is described succinctly by Smalley (1989:406), "The larynx moves upward with the vocal cords during the articulation of the consonant, and this creates air pressure in the pharynx. When the consonant articulation is released, the air rushes out, thus creating an egressive air stream which originates in the pharynx." Hockett (1955:35) is one of few sources which comment on the timing of the glottal and non-glottal gestures in ejectives, "To produce a glottalized stop, the glottis and the velic are closed and some oral closure is made; the muscles of [the] throat and mouth then squeeze the air contained in this completely closed chamber, causing pressure at all three closures. Typically the oral stop closure is released first, the compressed air bursting past the releasing closure, and then the glottis is

opened." This means that phonetically ejectives are consistently post-glottalized, meaning released in the mouth before the glottis is opened.

Implosives are described as being the mirror image of ejective consonants. This class of consonants also consists of a glottal closure and an oral closure, except they are articulated "by lowering the larynx [and] air enclosed between an oral occlusion and the laryngeal constriction is rarefied…air flows in through the mouth when the oral closure is released" (Maddieson 1984:99). Greenberg (1970), and others, point out that implosives are consistently pre-glottalized; meaning that release of the glottal gesture comes before release of the oral gesture phonetically.

The Xinkan consonant inventory exhibits two of these three kinds of consonants: ejectives and glottalized resonants; consequently, these languages offer nothing concrete to say about any claims for implosives. Implosives consonants do no figure into the discussion of this paper, though following from the general indications below, any generalization which was formulated to capture the patterns of implosives needs to be revisited and tested for validity.

Concerning the two types of glottalized consonants discussed in this paper, an overwhelming majority of the literature has focused on ejectives; however, there are a handful of studies which discuss the patterns of glottalized resonants. For this paper this means that the discussion focuses more on ejectives than glottalized resonants. It is hoped that as more research is conducted on glottalized resonants, more generalizations will be made that can be tested against diverse languages. The generalizations discussed in this paper focus on the phonological and acoustic patterns described in the literature.

It is argued that these patterns reveal some typological tendencies that may be applicable to language in general. The phonological patterns largely deal with the symmetry (or lack

thereof) of consonant inventories that contain glottalized consonants. The acoustic patterns are concerned with the acoustic correlates for this kind of consonant and their cross-linguistic comparability. As seen in section 3 below, however, these generalizations fail to capture the patterns exhibited in Xinkan. This highlights the fact that the generalizations are based on poor sampling of the world's languages for the segmental generalizations and on inconsistent methodology for the phonetic generalizations.

In section 2 the Xinkan consonant inventory is surveyed. Section 3 is divided into two sub-sections. The first deals with the typological significance of the consonantal segments exhibited in Xinkan and is discussed in light of the generalizations discussed in Greenberg (1970) and Maddieson (1984) and (2005). In the second sub-section the implications of the Xinkan system on the phonetic generalizations surveyed in McDonough and Ladefoged (1993), Lindau (1986), Wright et al. (2002), Howe and Pulleyblank (2000), and others, are discussed. Section 4 reports the conclusion.

2. Xinkan Consonants

Xinkan is a small language family of four languages in southeastern Guatemala. The individual languages have names following the town in which they are (or were) spoken. They are Guazacapán Xinka, Chiquimulilla Xinka, Jumaytepeque Xinka, and Yupiltepeque Xinka. However, only two of the languages (Guazacapán Xinka and Jumaytepeque Xinka) are still remembered by a handful of semi-speakers. This means that desired new data needed to test many of the hypotheses described below will not be available. Fortunately, however, enough data on three of the four languages has been recorded and is available still making these languages important to linguistic theory. However, it should be noted that the data used in this paper come from a corpus not designed to collect data explicitly for the purposes here, especially

the phonetic patterns discussed in section three. This does not, however, discredit any findings in this paper; but only argues the more clearly for appropriate methods of language documentation and description (see Good 2004). The languages used in this paper are Guazacapán Xinka, Chiquimulilla Xinka, and Jumaytepeque Xinka. All of the Xinkan data presented in this paper are taken from corpus of materials in Rogers and Fox (unpublished database) and my own fieldwork.

These three languages have very similar segment inventories and are considered together in this section, though any claims that cannot be generalized to the whole family are indicated. In Table 1 contrastive phonemic segments of Xinkan that appear in at least one of the Xinkan languages are given. Language specific differences are indicated after the Table.

Table 1 Xinkan Consonant Inventory

		Labial	Labio-Dental	Alveolar	Retro-Flex	Palatal	Velar	Glottal
Stops	Voiced	b		d			g	
	Voiceless	p		t			k	
	Ejective	p'		t'			k'	ʔ
Fricatives	Voiceless		f	s	ʂ̌			h
Affricates	Voiceless					ts		
	Ejective			ts'		ts'		
Nasal	Plain	m		n				
	Ejective	m'		n'				
Lateral	Plain			l				
	Glottalized			l'				
	Fricative(vcls.)			ɬ				
Approximants	Plain	w		r		y		
	Glottalized	w'		r'		y'		

One important note about the nature of the phonetic symbols used in Table 1 is important in order to avoid confusion. In the IPA the symbol /ɬ/ is listed as a voiceless lateral fricative (as it is in Table 1), characterized by strong frication. However, in Xinkan (as in a number of other languages of Native America) the sound represented by this symbol is merely a voiceless /l/ or

more specific a voiceless lateral approximant. This latter sound has weaker frication than a lateral fricative. The symbol in Table 1 represents this latter description and is used to follow tradition and to avoid the confusion which might be caused by a more accurate symbol like /l̥/.

The majority of the consonants represented in Table 1 are exhibited in all of the Xinkan languages; however, there are three minor language specific differences that should be noted. First, the entire set of voiced stops is only contrastive in Jumaytepeque Xinka, whereas only /b/ and /d/ are contrastive in Chiquimulilla Xinka; in Guazacapán Xinka these segments are allophonic realizations of their voiceless counterparts when preceded by a nasal. Second, the /f/ segment is only exhibited in the Chiquimulilla Xinka sound system and in neither of the other two languages. Lastly, /ɬ/ is exhibited in the inventories of Chiquimulilla Xinka and Guazacapán Xinka, but not Jumaytepeque Xinka. While interesting, none of these differences involves either the ejectives or the glottalized resonants, and consequently do not affect the discussion in this paper.

3. Generalizations concerning glottalized consonants

This section deals with the general patterns of both ejective consonants and glottalized resonants. The generalizations can be divided into kinds: those that deal with the hierarchies of segments exhibited in a given language's sound system, and those that discuss the acoustic correlates of ejective consonants. These are discussed in order.

3.1 Segmental Generalizations

In this section the typological significance of the Xinkan system is discussed and the proposed tendencies for ejectives are refined. Specifically it is shown that the Xinkan system of glottalized consonants presents a problem for the place tendencies of ejective consonants discussed in Sapir (1938), Greenberg (1970), and Maddieson (1989) and (2005). These studies

claim that ejective consonants prefer back articulation, and that languages tend to avoid labial ejectives. The fact that Xinkan has labial ejectives, which occur quite frequently, bears on this generalization.

While typological generalizations about glottalized consonants are found in a number of studies, they all seem to stem from three sources: Sapir (1938), Greenberg (1970), and Maddieson (1989). The claims made in these three sources are given here as a list of the many important generalizations made concerning ejective consonants. This short list is followed by a discussion of the problems of each.

In Sapir (1938), the ejective consonants of Nootka, Navajo, and Kwakiutl are discussed typologically and diachronically. Sapir arrives at two generalizations on the distributional patterns of these consonants.

1. "[In] the overwhelming majority of the cases the glottal release is posterior to the oral release"
2. "Of greater frequency, it would seem, than glottalized voiceless spirants are glottalized sonorant consonants."

Both of these observations, though accurate, are uninteresting. The first deals with a defining characteristic of this kind of consonant (though not for glottalized resonants), and therefore goes without saying. The second statement also seems to follow from definitional attributes of glottalized consonants; glottalized fricatives are rarer in the world's languages because of the difficulty of their production (see Smalley 1989: 406). The most often cited languages with ejective fricatives are Yuchi (Isolate), Kabardian (Caucasian), Berta (Nilo-Saharan), Socotri (Afro-Asiatic: Soqotri), Tlingit (Na-Dene), Mazahua (Oto-Manguean), Wichita

(Caddoan), Dakota (Siouan), Koma (Niger-Congo), Acoma (Keresen); all of these languages also have ejective stops and figure in the discussion below.

Similarly, Greenberg (1970) looks at ejective consonants on a typological level by commenting on the patterns observable in a handful of languages. While the sample that Greenberg used was not balanced (i.e. not representative of languages in general) the claims did push the typological study of ejectives forward. Greenberg posits six typological generalizations.

1. "The typical ejective obstruent is unvoiced and has abrupt onset (i.e. is a stop or affricate)" (p.124)
2. For the obstruent ejective…the glottal occlusion is normally released after the oral occlusion." (p.124)
3. The ejective consonant appears always to be unvoiced." (p.125)
4. The glottalic sonant is rather more like the injective than the ejective obstruent" (p.127)
5. Ejectives tend to have back articulation. (p.127)
6. For the ejective, spirants are also relatively infrequent and always imply the presence [in the language] of some ejectives with abrupt onset (i.e. stop or fricatives). (p.130)

Most of these six statements also follow from the defining characteristic of these consonants and are therefore uninteresting. Generalization (1) follows from the difficulty of producing a glottalized fricative pointed out by Sapir. Statement (2) is true by definition. Claim (3) refers to the physical limitations on ejectives caused by their required articulation. An ejective is unvoiced because the air which would normally cause the vocal fold vibration is cut off by the closure of the glottis. Statement (4) appears to refer to the timing of the glottal event which is traditionally assumed to be pre-glottalized for both implosives and glottalized resonants.

Statement (6) provides a nice implicational universal to be tested, though it too seems to follow largely from physiological constraints – with the fricatives typically the air stream is not sufficiently blocked to get the glottal closure needed to build up the pressure to get the ejective quality more common with stops and affricates. This leaves only the generalization in (5) which forms the base for the discussion in this section.

More recently, Maddieson (1986) and (2005) refined Greenberg's generalizations by using a more balanced sample of the world's languages and by providing possible phonetic explanations for some of the generalizations. These studies were based on the UPSID (UCLA Phonological Segment Inventory Database) and provide a first exciting look at phonological typology.

In the UPSID database, as reported in Maddieson (1984), there are almost equal numbers of languages with either ejectives or implosives; 57/317 and 55/ 317 respectively. However, there are only 3/317 languages with only glottalized resonants. This is not to say there are only three languages with glottalized resonants because there are 19/317 that have both ejectives and glottalized resonants in their inventories and 4/317 that exhibit both implosives and glottalized resonants. This makes the total of languages with at least one glottalized resonant 24/317. This total number of languages is still extremely small among the sample (7.5%), and importantly these numbers show that the glottalized resonants are more likely to co-occur in languages with ejectives than implosives.

As far as generalizations about the ejectives, these numbers show that they are slightly more common than implosives and much more common than glottalized resonants. Maddieson reports that the languages in UPSID do not contradict Greenberg's claim that ejective prefer back

articulation and adds two implicational universals for ejective consonants shown in (5). No substantial new patterns are reported in Maddieson (2005).

(5) Implicational universals

a. /k'/ ⊃ /t'/ ⊃ /p'/ ⊃ /q'/ ⊃ /?/

b. fricatives ⊃ affricates ⊃ stops

In summary a list of the most salient generalizations concerning glottalized consonants is given below. This is then followed by the implication of each for sound inventories like Xinkan.

1. The order of release it first oral then glottal
2. Ejectives tend to be unvoiced
3. Glottalized resonants are more like implosives than they are like ejectives
4. Glottalized resonants occur in a language's inventory most commonly with ejectives.
5. Ejectives tend to have back articulation
6. The manner hierarchy: fricatives ⊃ affricates ⊃ stops
7. Order of ejective acquisition: /k'/⊃ /t'/ ⊃ /p'/ ⊃ /q'/ ⊃ /?/

The first of the generalizations at first sight might seem unnecessary as it seems to describe a definitional property of ejective consonants. However, this pattern is important in the growing literature on the phonetics of glottalized consonants. In these studies the timing of the release of the two occlusions is essential to an accurate characterization of ejectives, especially following from the idea given in Lindau (1984) that there are 'weak' and 'strong ejectives that vary from each other in a number of phonetic characteristics.

The second generalization is also well attested in the world's languages. In the UPSID database there is only one language, !Xu, that is reported to have voiced ejective consonants.

However, these sounds are called into question by the mechanics of ejective production. In order for a consonant to be produced as an ejective there must be a complete glottal closure by definition. This closure occurs above the vocal folds and so vibration of a voiced consonant would be unheard1. It might be that the voicing of the consonant in !Xu happens after the glottal release or that there is some kind of air leak through the folds, but this is speculation that must be tested phonetically. Lindau (1984) reported phonetic research on the voicing of ejective consonants in Hausa and Navajo, which supported the implausibility of voiced ejectives.

The third generalization seems to be supported by most, if not all, languages with ejective consonants. The reason for this might be found in the difficulty in producing an ejective fricative. An ejective consonant requires an oral and glottal occlusion, however, with a fricative there is only a partial oral closure and a complete glottal one. This means that ejectives fricatives are rare due to their difficulty of production going against a functional explanation of optimal phonemes being partly those with the greater ease of articulation. The Xinkan inventory is consistent with the fourth generalization -- it contains both glottalized resonants and ejective consonants. This, however, is necessarily only a tendency as there are a number of the languages which do not have the combination.

The fifth generalization given above is an interesting one. It comes from a suggestion in Greenberg (1970) where he argues that both implosives and glottalized resonants are both typically voiced and related to preglottalized/laryngealized consonants. There is phonetic evidence that those consonants which have been described as implosives (see Ladefoged 1968 and Pinkerton 1980) might more appropriately be label as laryngealized consonants and/or simply pre-glottalized. This paper does not add to these observations but merely highlights the fact that the claim that implosives are similar to glottalized resonants also needs more attention

phonetically. A number of studies have begun the work of an accurate phonetic characterization of glottalized resonants. (Aoki 1970, Lindau 1984, Warner 1996, and Wright et al. 2002).

The last two generalizations claim that velar ejectives here more common that alveolar and labial ones and that alveolar ejectives are more common than labial ones, arguing that languages prefer ejectives produced farther back in the mouth. The rest of this section focuses on a discussion of this claim.

The claim that ejectives prefer back articulation is exciting because it seems to narrow down the possible consonant inventories of languages thus aiding in language description, typology, and historical reconstruction. Despite these benefits, this observation is only useful if it consistently holds true in the world's languages. The Xinkan system seems to be inconsistent with this claim because it has labial ejectives. Specifically an inventory like that exhibited in the Xinkan languages requires the tendency to be against the deficit of labial ejective consonants and not an implication of a preference for back (i.e. velar) articulation. The claim of this paper, in fact, is that the typological generalization that ejective consonants prefer back articulation is based on an inaccurate representation of the data and is therefore questionable.

Campbell (1973) argued that generalizations which argue for a preference for back articulation for ejectives might characterize a common typological pattern, but can in no way be considered a universal. If the consonant inventory itself is compared as a whole a possible explanation for the back preference is apparent. That is that when considered in light of the plain consonants in an inventory the lack of labial ejectives is not surprising because of the these language are deficient in labial consonants in general not just ejectives (this is discussed more in depth below). Additionally, typology researchers have often cautioned about the need for a balanced language sample. To be accurate a generalization must be based on languages that are

both genetically and geographically diverse. These two issues seem to be especially relevant to the case of the UPSID data.

As mentioned above, Maddieson (1984) discusses the sound patterns of the 317 languages that make up the UPSID database. These patterns are discussed in detail and Maddieson highlights phonetic explanations and gives phonological reason for any exceptions encountered. The patterns of the ejective consonants in UPSID provide a useful summary of the typology of these sounds. This summary includes the claim that ejective consonants prefer back articulation which was mentioned in (5) and (6) above.

In order for a generalization to be made like those in (5) and (6) above which argues that ejective consonants are most commonly produced in the back part of the mouth, a comparison of both plain and ejective consonants is important. In the UPSID database 49 languages of the 317 have velar ejectives (15%), 49 have dental/alveolar ejectives (15%), and 33 have bilabial ejectives (10%). This confirms the generalization that ejectives are produced in the back of the mouth more commonly than in the front. However, because the dental/alveolar ejectives occur with equal frequency to the velar ejectives, the argument for backness does not seem a proper way to state a generalization. In order for this generalization to hold true it would be necessary to conflate the coronal and dorsal areas of articulation into one single back region of the mouth. This might cause problems for phonological work and an accurate description of the phonetics of the sound produced in these two places of articulation. One obvious solution, therefore, would be a statement that ejective consonants are more likely for non-labial points of articulation; or languages disfavor labial ejective consonants somewhat, with a third fewer labial ejectives than non-labial ones. It is this generalization that is tested.

Maddieson (1984) says that the frequency of non-glottalic plosives in the world's languages (as represented in UPSID) is not similar to the observations of their ejective counterparts: the velar place of articulation (99.4% of the UPSID languages) is slightly more common than that labial place of articulation (99.1% of the UPSID languages) and slightly less common than the dental/alveolar place of articulation (99.7% in the UPSID languages). However, Maddieson also reports that no language has an ejective consonant without also having a plain consonant at an identical place of articulation: "this means that ejectives should be expected to occur only at the places where non-glottalic stops occur" (Maddieson 1984:107). This might point, then, to the fact that ejective velar consonants are more common than labial ones because the velar place is more common in general. However, it is obvious that the commonality of the back place of articulation is not statistically significant when compared to the labial place of articulation.

As mentioned above 36% (19 of the 52 languages with ejective consonants) of the languages in the UPSID database area are said to have at least on ejective but none at the labial place of articulation. Closer scrutiny of the 19 languages that are said to avoid labial ejectives, however, presents problems for these typological generalizations. A review of the 317 languages revealed only 17 languages that had at least one ejective consonant but no labial ejective (5.4%): Haida, Hupa, Navajo, Chipewyan, Tolowa, Socotri, Hamer, Dizi, Kullo (Kutto), Tigré, Hausa, Zuni, Ik, Wichita, Mazahua, Q'eqchi', and Itonama. Of these seventeen languages 5 belong to the Na-Dene family of languages and are all part of the so-called Northwest Coast linguistic area (where labials, whether glottalized or not, are only weakly present in a number of languages), 6 belong to the three branches of the Afro-Asiatic family and are spoken in a geographically close area, and 6 are either isolates are not related to any other language of the 17.

While the genetic relationships between these African languages are admitted in the Maddieson's (1984) report of the UPSID data, the geographical connections are omitted. Comrie (1989) argues that for an observed pattern to by typologically accurate the sample must be free from genetic and geographical relationships. Furthermore one common observation of some linguistic areas, such as the Northwest Coast of North America, is that they disfavor labial articulations in general (Campbell 2006: 335 -337). This would mean that a labial ejective would be marked in relation to the respective consonant inventories because labial consonants in general are so marked. Maddieson (1984:107) comments that many of the languages in the UPSID database that do not have labial ejectives are deficient in labial segments in general which is said to support the claim that "languages have stops of different series at the same place of articulation".

In light of the precautions about similar places of articulation for ejective consonants and their plain counterparts, it is essential to make sure that the languages used in the formation of this generalization are not deficient for typological reasons. This suggests that the observed preference for back articulation of ejective consonants is not as strong as was suggested. That seeming preference for non-labial ejective can be explained quite easily if each segment inventory is considered internally before it is considered cross-linguistically. That is, that each language needs to be examined as unit to see how the ejectives pattern within their individual systems before the apparent pattern in favor of a back articulation for ejectives can be considered applicable to languages in general.

In order to support the claim that labial ejectives are only disfavored in inventories where labial consonants in general are disfavored a complete list of the languages from Maddieson (1989) that have at least one ejective consonant are given in Table 2. Additionally Table 2

provides the raw counts of the number of series (voiced, voiceless, ejective, implosive, aspirated etc.) in each inventory compared to the total number of gaps in the inventory and the number of gaps at the labial place of articulation. The numbers represent only the figures for stops and affricates taken together and avoiding nasals, fricatives, and approximants. As a means of comparison Xinkan is given as the last entry in Table 2.

Table 2 Internal Considerations of Ejective Patterns

Name	Stop/Affricate Series	Total Gaps	Labial Ejectives	Labial Gaps
Navajo	3	4	N	2
Chipewyan	3	12	N	2
Tolowa	3	8	N	2
Hupa	3	3	N	3
Mazahua	5	7	N	2
Zuni	3	6	N	2
Itonama	3	5	N	1
Kullo	4	8	N	3
Dizi	3	4	N	2
Wichita	3	5	N	3
Tigre	3	4	N	2
Socotri	3	2	N	2
Hamer	4	7	N	1
Hausa	4	8	N	2
K'ekchi	2	0	N	1
Ik	4	12	N	1
Haida	3	1	N	1
Zulu	4	5	Y	0
Eastern Armenian	3	0	Y	0
Tlingit	3	0	Y	0
Nez Perce	2	1	Y	0
Klamath	3	0	Y	0
Maidu	3	2	Y	0
Wintu	4	6	Y	0
Chontal	3	3	Y	0
Tzeltal	3	2	Y	0
Otomi	5	10	Y	0
Nootka	2	0	Y	0
Kwakw'ala	3	0	Y	0

Quilente	3	6	Y	0
Squamish	2	0	Y	0
Puget Sound	3	4	Y	0
Southeastern Pomo	3	4	Y	0
Yana	3	0	Y	0
Shasta	2	0	Y	0
Acoma	3	1	Y	0
Dakota	4	3	Y	0
Yuchi	4	0	Y	0
Wappo	3	3	Y	0
Southern Nambiquara	4	2	Y	0
Quechua	3	0	Y	0
Jaqaru	3	0	Y	0
Gununa-Kena	3	6	Y	0
Georgian	3	2	Y	0
Kabardian	3	4	Y	0
Lak	4	5	Y	0
Kefa	3	0	Y	0
Berta	2	2	Y	0
Koma	4	1	Y	0
Amharic	3	0	Y	0
Xinkan	2	1	Y	0

The languages which are said to have at least on ejective but none at the labial place are given in boldface, and those with labial ejectives are provided directly after. Table 2 shows for most of the languages that have at least one ejective but none at the labial place there are gaps in the inventory at the labial place. This means that it is not surprising that these languages are deficient in labial ejectives because they are deficient in other labial consonants. For example, Navajo has three series of stops and affricates (voiceless, voiceless aspirated, and ejective) and has only one series (voiceless) with labial consonants. This language cannot be expected to indicate general patterns because of the unique organization of its consonant inventory.

Hamer (Afro-asiatic) is another example; it has a full set of implosives and only one ejective at the velar place of articulation. The uncommon occurrence of languages having both

implosives and ejectives, points to a possible explanation for this aberration. It has imploded stops in a number of places of articulation though there is a gap at the velar place where the inventory exhibits an ejective instead. It would seem that a typological generalization based on this language alone would be against velar implosives rather than labial ejectives

In the original study of the UPSID data of the 52 languages with at least one ejective consonant 17 did not have labial ejectives (33%); this is supported by the information in Table 2. However 33 languages have labial ejectives (63%); Xinkan falls into this latter category. This seems inconsistent with the claim that ejective 'disprefer' labial ejectives as the majority of languages with ejectives also have labial ejectives.

Additionally, when the sample of languages is controlled for genetic and areal relationships as discussed the percent of languages falling in the category is greatly reduced. From a genetic perspective every language family should be considered a single instance of evidence for the preference for back ejectives. This means there would only be 8 languages in the sample that display the expected consonant patterns. On the other hand if each major branch of a language family represented in the sample is considered the number of languages with the pattern is slightly increased. For example, there are three branches of the Afro-Asiatic (Omotic, Semitic, and Chadic) and two branches of the Na-Dene (Athabaskan and Na-Dene proper) families represented in the sample. A more conservative sample then might consider each branch a viable instantiation of the patterns of ejective consonants bringing the total number of languages with that have at least on ejective but none at the labial place to 11. This means that depending on the perspective taken on genetic relationships and typological validity 15%-21% of the languages in the UPSID sample display the expected pattern.

However, if the languages are further refined by areal and internal considerations, the number of languages seen to display the pattern is drastically small. That is, in order for the generalization about the preferred place of articulation of ejective consonants to be valid typologically it is beneficial to exclude all the languages that do not display the patterns for internal reasons (i.e. the languages disfavors labial consonants in general). These internal considerations were presented above in Table 2. Those languages which show an internal inconsistency should be excluded from the sample set. Taken together into account, internal considerations, genetic relationships, and areal affiliation discredit the claim that ejective consonants prefer back articulation.

Although the Xinkan system appeared at first glance, not to conform to the claim that ejective consonants prefer back articulation, with closer scrutiny it is seen that this is not the case. This generalization is based on a bad typological sampling of the world's languages and therefore has difficulties in accounting for language patterns in general. The Xinkan consonant inventory is typical for languages which have ejective consonants and are not deficient in labial consonants in general.

3.2 Phonetic Generalizations

Similar to the typology of consonant inventories discussed in section 3.1, a number of studies indicate that an acoustic typology might be constructed for ejective consonants. This typology is based on a number of acoustic features of ejectives and divides this class of ejective consonant into strong (fortis) and weak (lenis) (see Kingston 1984). The features used to establish this typology include the timing of the oral and laryngeal gestures, VOT, release amplitude, jitter, closure duration, and perturbations in the acoustics of the following vowel. However, like the inventory typology, the acoustic typology is also based on inconsistent

methodology, and is therefore dubious. This section surveys the claims about this acoustic typology and shows why it is faulty.

Acoustic measurements of ejectives led Kingston (1984) to posit the classification of at least two types of ejectives: fortis and lenis. Since then a number of studies have concentrated on the use of this division in order to describe adequately a number of languages' sound patterns and have added to the characteristics used in this dichotomy. Table 3 shows the acoustic characterization of each of these types of ejectives as summarized in Wright et al. (2002), Kingston (1984), and Ingram and Rigsby (1987).

Table 3 Two Types of ejectives consonants

Acoustic Characteristics	Strong Ejectives	Weak Ejectives
total Duration	long	short
closure duration/VOT	small	large
burst	intense	normal
VOT	long	short
f0 of the following vowel	high	low
voice quality	modal or tense	creaky
rise time	fast	slow
vowel onset	abrupt	gradual

Like the segment typology discussed in section 3.1, the typology presented in Table 3 could be a useful descriptive tool and might add to our understanding of general language patterns. However, the claim is useful only if it is accurate; it becomes questionable upon closer scrutiny of the methodologies used in the studies which find supportive evidence for this pattern. Specifically, the problems are a consequence of the inconsistency in the number of languages used in each study, the phonetic context of the consonant under investigation, the place of articulation of the consonant being studied, and the overall phonological inventory of the languages involved. For each study one or more of these variables was different, meaning that any differences in the acoustic characteristics of ejectives in these languages might be related to

these variables instead of any inherent typological pattern. Therefore these studies represent serious threats to the validity of the claims they represent.

The number of languages used in a comparison of cross-linguistic patterns is essential to ensuring that the generalizations discovered are valid both internally to the dataset and externally to other languages not used in sample. This was explicitly shown in section 3.1. The generalization that ejectives prefer back articulation was able to explain the patterns observed in the languages used in the sample. However, when applied to languages that had not been included in the original sample, it was unable to account for an apparent contradiction. This led to the refinement of the dataset in order to make the generalization valid for languages in general. This clarification led to a rejection of the claim that ejectives prefer back articulation. For the acoustic typology represented in Table 3, the same problem arises. The generalizations are not able to account for languages not in the original sample.

This specific problem was pointed out in Warner (1996). She indicates that the strong/weak division of ejective consonants, indicated in Table 3, is problematic because the datasets used to create this dichotomy contained only two languages: "Most previous cross-linguistic comparisons involved two languages each, and this obviously allowed for a two-way division of ejectives into tense and lax or strong and weak." (p.1528) For example Lindau's (1984) study of ejectives involved only Navajo and Hausa. This means that the findings of the study may not be applicable to other languages or a larger sample of languages. Similarly, Ingram and Rigsby (1987) include only one language (Gitksan, Tsimshian) in their study with cursory mention of a comparison to another language (Chipeweyan, Athabaskan).

To make this typology more valid, Warner (1996) compared eight languages for the acoustic characteristics highlighted in Table 3 in order to find out if they were able to distinguish

between strong and weak ejectives. She used the data found in a number of studies and added one new language, Ingush, for her comparison. Her findings, replicated in Table 4, however, indicate that this acoustic typology is dubious and needs to be refined because "no two languages pattern together for all the characteristics". (p.1528) This might indicate the that typology set up in Table 3 lacks the predictive power and explanatory adequacy for the phonetic patterns in the world's languages.

Table 4 Table Warner's (1996) findings

Acoustic Characteristics	**Ingush**	**Hausa**	**Quiché**	**Navajo**	**Tigrinya**	**Salish**	**Chechen***	**K'ekchi**
Pitch of the following vowel	higher	-	lower	-	higher	-	-	-
VOT of velar ejectives (msec.)	50	25	50	80	~80	86	7-33<plain	97
Closure duration/VOT	1.94	~2	-	~1.5	-	-	-	-
Post-burst noise amplitude	low	low	low	low	silence	-	-	-
Rise to full amplitude of vowel	slow	normal	slow	very fast	fast	-	-	-
Voice quality at vowel onset	aperiodic	aperiodic	creaky	modal	modal	-	-	-

*The measurements for Chechen are given only as 7-33 msecs. less than plain stops and is a measurement for bilabial and alveolar ejectives combined.

Similarly, Wright et al (2002) found that this acoustic typology was problematic when applied to the ejectives exhibited in a single language Witsuwit'en (Athabaskan), "we found the typology to be inadequate to predict the range of variation in Witsuwit'en ejective production" (p. 70). This study found that there were a considerable number of differences in the production of ejectives, acoustically, between eleven speakers of the language. Neither the speakers taken individually or as a group showed patterns which followed those predicted in Table 3. This again highlights the point that the differences resulting in the acoustic typology may be a consequence of a number of variables not just acoustic characteristics.

Another issue resulting in the invalidity of this typology is found in the inadequate use of a standard of comparison. This issue is based on the fact that the acoustic characteristics described in Table 3 are mostly comparative words. For example, VOT is listed as "long" for strong ejectives and "short" for weak ejectives. This may be an accurate characterization but they are long or short compared to what? In some studies the measurements of ejectives were compared to the measurements of plain stops in the same language and not to other ejectives in other languages. Often it is this relationship between plain and ejective stops that is said to be positive evidence for the typology. In reality this only indicates language internal patterns and not patterns found in languages in general. Specifically, there is no empirical reason that the internal comparison should hold across languages; plain stops may have a longer VOT in one language compared to another and this skew the cross-linguistic comparisons and invalidate this generalization.

Additionally, in all studies used to provide supporting evidence for this typology, the place of articulation of the ejective was not overtly controlled for when making cross-linguistic comparisons. Although most of the language studied came from languages which only had velar and alveolar ejectives, there was not consistency in the choice. For example Lindau (1984) discussed the patterns of velar ejectives in Hausa and Navajo, while Wright et al (2002) discussed only alveolar ejectives of Witsuwit'en. In contrast Hogan (1976) studied the mean VOT for all ejectives at all places of articulation in Chipweyan, this included labial, alveolar, and velar stops. This is important because it is universally true "for velar stops to have a longer VOT than stops made at a more anterior position" (McDonough and Ladefoged 1993:154). When the place of articulation is not held constant across all the languages used in a cross-linguistic

comparison, differences or similarities in the acoustic phonetics of ejective consonants are likely to surface as a result of the place of articulation instead of general patterns.

Lastly, often in the comparison of acoustic measurements across languages, the phonetic context of the consonants was not held constant. For example, some studies, like Flemming, Ladefoged, and Thomason (2008) and Lindau (1984) ensured that the consonants were in an intervocalic position; while others like Ingram and Rigsby (1987) studied ejectives in word initial position. Furthermore, only Hogan (1976) controlled explicitly for the influence of the following vowel on the consonants by measuring each ejective before many different vowels in the language. Others studies of individual languages have controlled for this by making sure that all the following vowels were of one type (e.g. [a]-like) though when the findings are compared cross-linguistically this is often not considered in the putative patterns.

Table 5 shows a comparison of VOT for 14 languages found in other acoustic studies of ejective consonants and Xinkan. In order to show the problems with the validity of the findings of the cross-linguistic comparisons of ejective consonants the phonetic context, the following vowel, and the place of the articulation of the consonants used to measure the VOT are also provided. Blank cells mean there is no available information for this variable.

Table 5 methodology problems

	Language	VOT	Context	Vowel	Place
1	Chipeweyan	88.42	V_V	mid lax front	Labial, Alveolar, Velar
2	Chipeweyan	109	V_V	low	Labial, Alveolar, Velar
3	Chipeweyan	124.17	V_V	mid back tense	Labial, Alveolar, Velar
4	Gitskan	89.2	#_CV'		
5	Hausa	25	V_V	a-type	Velar
6	Ingush	50	#_CV' and V_V	Various	Velar
7	K'ekchi	97			
8	Montana Salish	86	V_V		Velar*

9	Navajo	108	V_V		Alveolar
10	Navajo	94	V_V		Velar
11	Navajo	80	V_V	a-type	Velar
12	Quiche	50			
13	Tigriynya	80			
14	Witsuwit'en	32	#_CV'		Alveolar
15	Xinka (Guazacapán)	48	V_V	Various	Velar

*This is a meaurment of glottal lag not VOT

All the Chipeweyan (1-3) data come from Hogan (1976); the Gitskan data come from Ingram and Rigsby (1987); the Hausa (5) and Navajo (11) come from Lindau (1984); Ingush (6), K'ekchi (7), Quiche [K'iche'] (12), and Tigriynya (13) are discussed in Warner (1996); Navajo (9-10) is discussed in McDounough and Ladefoged (1993); and the Witsuwit'en data is borrowed from Wright et al (2002).

As indicated in Table 5, the VOT for ejectives in each language is different. However it is difficult to determine whether these values can be divided into two groups because of the inconsistency of the phonetic context, the following vowel, and place of articulation. This consequently makes it problematic for determining if the Xinkan system is predicted by this typology.

4. Conclusion

Cross-linguistic comparisons are promising as an empirical pursuit because they can validate claims about the general patterns of language. They provide a test for the many hypotheses about language. These comparisons often result in generalizations which are assumed to hold true for most (if not all) of the world's languages. This is definitely the case for the glottalized consonants discussed in this paper. However, these tendencies are called into question when they are based on faulty methods of comparison.

For the generalizations made about ejective consonants this is especially important because the patterns are based on language comparisons which have not been controlled in an appropriate way. Specifically, generalizations made about ejectives compare languages which are related areally or genetically, or both, and can only be assumed to be representative of the languages which fall within those relationships. Furthermore acoustic patterns describing ejectives are problematic because they are based on methods which do not control for the effects of essential variables.

In this paper an attempt was made to show how these generalizations might be applied to the patterns of a single language family: Xinkan. It was shown that for the segmental typology of ejectives, Xinkan languages seemed to be an exception to the rule that ejectives prefer back articulation. While for the typology of the acoustic characteristics of ejectives it was shown that it is difficult to know how to compare the findings for Xinkan to other languages with this class of consonants. Furthermore it was argued that although the cross-linguistic comparisons are beneficial to the understanding of general patterns of language, they must be controlled for in such a way as to not threaten the external or internal validity of the claims.

While it might be easy to say that following from the issues discussed in this paper, no patterns can be highlighted; however, it is the assumption of this paper that this is not the case. Patterns are expected to emerge in a comparison of this class of consonant cross-linguistically. However, these patterns should be based on comparisons and methods which do not threaten the external or internal validity of the claims; thereby ensuring that the patterns are applicable to other ‘new’ and ‘different’ languages.

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