[P. Spaelti, 1992]

A Feature Geometric Account of !Xóõ Bushman

1. Introduction

In the following paper I will be looking at !Xóõ, a language of the Khoisan language family of southern Africa. !Xóõ is spoken by San people living in an area along the border between Botswana and Namibia. The language has been described in great phonetic detail by Anthony Traill in a 1985 study (henceforth T85).

The Khoisan languages are best known for their clicks and their large segment inventories. !Xóõ is no exception. A property of the language which is less well known consists of a large number of restrictions on the distribution and co-occurrence of segments in the language. The challenge to any phonological description of the language is not only to invoke a theory powerful enough to describe the large number of segments, but also, and more importantly, to give a principled account of the restrictions on the distribution of these segments.

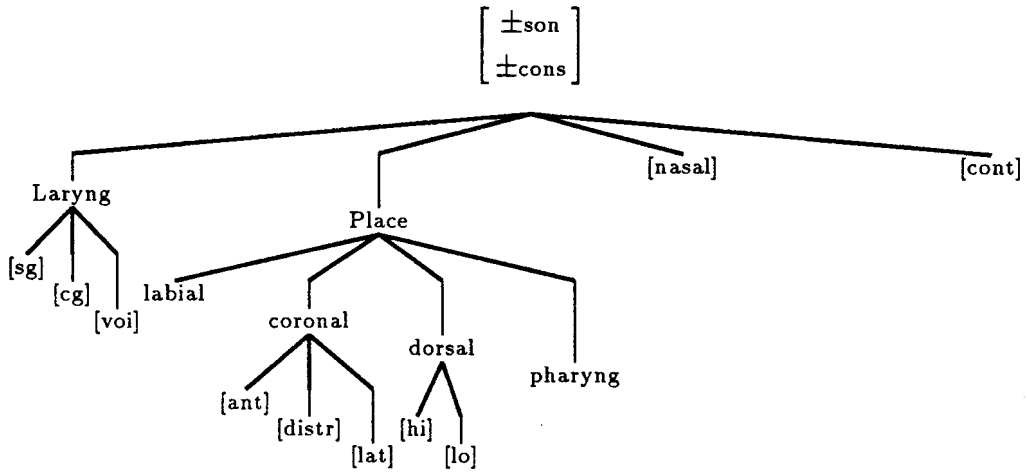
The theory of Feature Geometry, first proposed in Clements 85 and elaborated in Sagey 86, argues that complex segments such as clicks consist of structured groups of 'articulators' which are underlyingly unordered. This theory is paired with a theory of underspecification, which assumes that only non redundant aspects of the segments are underlyingly specified. Under such a conception the complete description of the phonological inventory of a language contains a number of redundancy rules, which determine how a given feature bundle is to be phonetically realized. The typical examples of such rules are so called feature filling rules. These fill in features of segments which are not underlyingly specified because they are redundant. For example voicing of sonorants etc. (see Itô and Mester 198?)

The discussion here will focus on a somewhat different type of redundancy rule, one which specifies the ordering of the underlying unordered complexes. It will be shown that this rule makes interesting predictions about the possible and impossible sequences of articulations, which are reflected in the language in the form of co-occurrance restrictions. Apart from the co-occurrance restrictions there are also restrictions on the distribution of segments in !Xóõ. It will be argued that a theory of prosodic licensing (as that first proposed in Itô 1986 and elaborated in Itô and Mester 1993 and Goldsmith 1990) can give an insightful description of these distribution restrictions. Then it will be shown how prosodic licensing and the rule on ordering of articulations interact to explain the various co-occurrance restrictions of the language.

Before addressing these questions I will give an overview of the inventory of the language and a basic characterization of the segments in terms of feature geometry. A descriptions of clicks in this framework is presented in Sagey (1986). The description in Sagey is in most respects also the one assumed here, although a number of details have

been changed. The reasons for these changes are two-fold. First certain details of feature organization, proposed in earlier models, which have failed to find further motivation, have been omitted. Examples of this are the supralaryngeal and the soft-palate nodes. Second some articulations which do occur in !Xóõ, do not have a ready description in the Sagey model. Examples of this kind are the uvular and pharyngeal segments. The basic feature organization assumed here is presented in (1).

(1)



This is essentially the model of McCarthy 1988. The analysis here also differs from Sagey (1986) in that it assumes that features are privative, since in !Xóõ it is only presence of a feature which is relevant to the processes talked about.

2. Inventory of !Xóõ

The segment inventory of !Xóõ can be divided into 3 groups: clicks, non-click consonants and vowels.

2.1 Clicks

Clicks in the Khoisan languages can be described phonetically as consisting of two parts; one the actual click, called influx, and a second consisting of accompaning articulation, called the efflux. The influx is formed by a double closure of the oral cavity, once at the back of the mouth, and once at either the lips, or the tip of the tongue. Following this, a slight lowering of the tongue body and a rapid release of the anterior closure, create the actual click. The efflux or, as T85 calls it, the accompaniment represents a wide variety of different articulations using the uvula and the larynx as well as the nasal cavity. Henceforth the influx will be freely refered to as the primary articulation and the accompaniment as the secondary articulation.

Click Influxes

The influxes of !Xóõ together with their IPA symbols are given in (2).

(2)

⊙	Bilabial click
|	Dental click
ǂ	Palatoalveolar click
!	(Post) alveolar click
‖	Alveolar lateral click

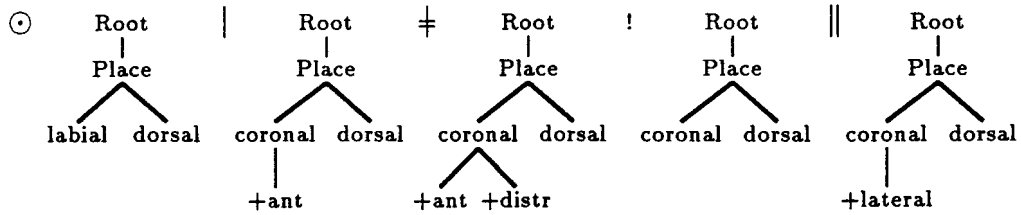
For the bilabial click the anterior closure is formed with the lips, while for the dental and the alveolar clicks the anterior closure is made with the tongue tip or blade. The alveolar clicks, ! and ‖, are apical, making the cavity between the anterior closure and the posterior closure rather large and the pitch of the click low, while the dental click, |, and the palatal click, ǂ, are laminal with a very small cavity and a rather high pitch. The alveolar ! and palatal ǂ clicks have instantaneous anterior releases, while for the bilabial ⊙, dental | and lateral ‖ clicks the release is slightly delayed giving them an affricated quality. There is no set of features which is generally agreed upon for the click influxes. The feature chart below, which contains some non standard as well as some redundant features, is taken from T85 (p 123).

(3)

	⊙	|	ǂ	!	‖
suction	+	+	+	+	+
back	+	+	+	+	+
dental		+	+	+	+
labial	+	-			
friction	+	+	-		+
laminal		+	+		
lateral	-	-	-	-	+
palatal	-	-	+		

Sagey argues convincingly that clicks are examples of what she calls complex segments. In general in Feature Geometry simple segments have a place node which is specified for one articulator. These are the segments common in most languages. According to Sagey, a click is an example of a segment which has more than one articulator attached to its place node. Moreover these articulators are unordered. The geometries which Sagey proposes for the influxes of !Xóõ can be seen in (4).

(4)



The primary motivation for these geometries is that they are phonetically accurate in the sense that the segments in question do have two closures in the places specified by the articulators. So a bilabial click, which has a labial and a dorsal articulator, has closures formed with the lips and the tongue body. For the further distinctions there is some phonological evidence. In particular marking | and ǂ in a way to distinguish them from the other coronal clicks ! and ‖. T85 describes the following rule.

(5)

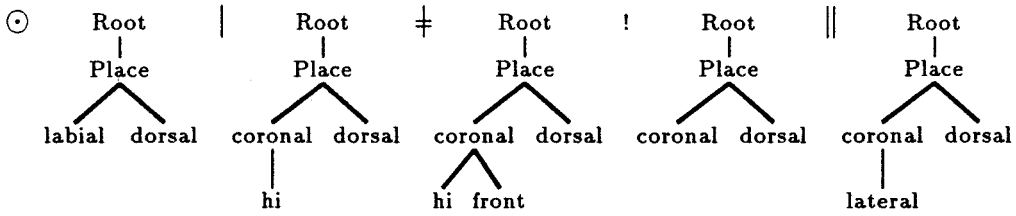
$$a \rightarrow i \; / \; \left\{ \begin{array}{c} | \\ ǂ \end{array} \right\} \_\_\_\_$$

A result of this rule are alternations such as that found in the pair |ʔìi 'lover' / |ʔàbatê 'lovers (pl.)'. T85 (p 91) argues that 'lover' should be regarded as consisting of an underlying morpheme |ʔà- with a noun class suffix -i. In the plural, a plural noun class suffix -ba- is added before the actual plural marker -tê (T85, p 12). Under Sagey's conception the feature [+anterior] on the dorsal node of the clicks | and ǂ will help single them out for the relevant exceptions.

There is a small problem with this proposal. The rule in (5) which looks very much like an assimilation is not properly captured if we use the feature [+anterior]' since /i/ is not usually taken to be [+anterior]. Instead it seems that the /a/ assimilates not to the surrounding anteriorness, but to the height. Since in the articulation of both of the clicks involved in this process, and in contrast to the other coronal clicks, the tongue body is raised, it seems more appropriate to use height as the distinguishing characteristic for these clicks.

Another problem arises with the use of the feature [+distributed] which is customarily used to mark laminals. Since T85 describes both the dental and the palatal click as laminal, they should both be [+distributed], thereby obliterating the distinction between them. But since the distinction is really one of palatalization, I propose to use [front] as the feature which marks the palatalized click. The full geometries assumed here for click influxes, using privative features, is presented in (6).

(6)



Click Effluxes

There are 16 different possible effluxes in !Xóõ. They all form combinations of voicing,

aspiration and ejective articulation (ie. glottalization) together with either a velar or a uvular place of articulation. For the uvular articulation there is also a contrast between stops and continuants. Aside from the velar and uvular cases there are also nasal accompaniments. (7) lists all the different possibilities, together with the symbols used in T85 (p 124) to transcribe them. Since the efflux symbols cannot be used alone they have been combined with an alveolar click influx [!].

(7)

1)	plain click	[!]	
2)	voiced	[!g]	
3)	delayed aspiration	[!^{h}]	velar
4)	voiced and aspirated	[g!^{h}]	
5)	glottal stop	[!^{ʔ}]	
6)	voiceless uvular stop	[!q]	
7)	voiced uvular stop with prenasalization	[ᴺ!ᴳ]	uvular stops
8)	aspirated uvular stop	[!q^{h}]	
9)	ejected uvular stop	[!q^{ʔ}]	
10)	uvular fricative	[!x]	
11)	voiced and uvular fricative	[g!x]	uvular fricatives/affricates
12)	ejected uvular affricate	[!kx^{ʔ}]	
13)	voiced and ejected uvular affricate	[g!kx^{ʔ}]	
14)	voiced nasalized	[!n]	
15)	voiceless nasalized	[!n̥]	nasal
16)	preglottalized and nasal	[^{ʔ}!n]	

Although at first glance there might seem to be a contrast between uvular fricatives and uvular affricates as well as one between fricatives and stops, affricates appear only with ejective articulation, while fricatives never do. Affrication can therefore be seen to be a predictable product of combining ejective and fricative articulation. All of these 16 effluxes can combine with any of the 5 influxes giving a total of 80 distinct segments. For the effluxes Traill and Ladefoged (1980) propose the following set of features.[1]

[1] Traill and Ladefoged actually propose that [!x] and [g!x] are specified for the value [–uvular]. T85 (p 139) changes this to [+uvularl. In this respect I am following the later.

(8)

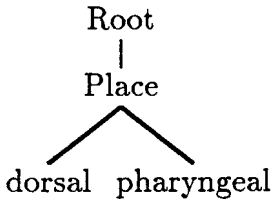
	!g	!^{h}	g!^{h}	!^{ʔ}	!q	ɴ!ɢ	!q^{h}	!q^{ʔ}	!x	g!x	!kx^{ʔ}	g!kx^{ʔ}	!n	!n̥	^{ʔ}!n
voiced	+		+			+				+		+	+		+
aspirated		+	+				+								
glottal				+				+			+	+			+
uvular					+	+	+	+	+	+	+	+			
fricative									+	+	+	+			
nasal						+							+	+	+

Sagey does not discuss the effluxes of !Xóõ directly, but only those of Nama and !Xũ (Žu|^{ʔh}oasi). The efflux system of Nama lacks the complexity of that of !Xóõ, while !Xũ's system is quite different from that of !Xóõ in many respects relevant to the discussion here. It will therefore be necessary to develop a system of representation for !Xóõ effluxes independantly. As was noted before the effluxes are all composed of combinations of 6 factors:

- voicing
- aspiration
- glottalization (or ejective articulation)
- uvular stop
- uvular fricative
- nasalization

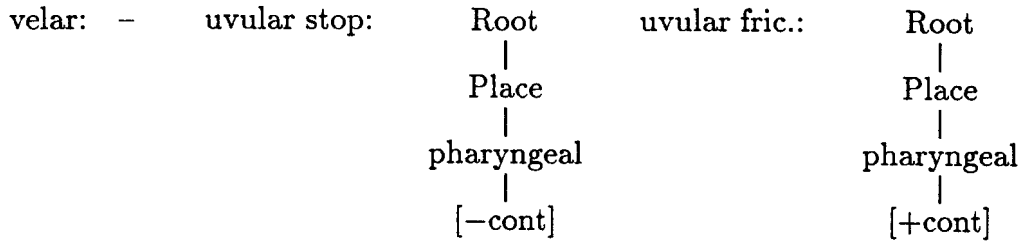
A first question which arises immediately with respect to the Sagey model, is how to represent uvulars. The McCarthy (1988) model permits a representation of uvulars with the following structure:

(9)



One point about effluxes is that all those which are not specified as uvular are by default velar. Velars have a place node specification of [dorsal]. Therefore velars and uvulars contrast only in the fact that uvulars have a [pharyngeal] node in addition to the [dorsal] one. But since we are discussing articulation which is added to a click and since clicks already have a [dorsal] node we can contrast velars, uvular stops and uvular fricatives minimally as in (10).

(10)



This form of representing effluxes makes an interesting prediction. While uvular effluxes do add something to a click, namely a [pharyngeal] articulator node, a velar efflux presumably adds nothing to the click, leaving it just the plain influx. This prediction is borne out as T85 (p 125) notes:

> The auditory distinction between (the velar and the uvular efflux) is *not* just the difference between a click followed by [k] and one followed by [q]; it is in fact the difference between a click followed by a vowel and one followed by [q]. The instrumental record provides very clear evidence of the difference.

With the representation of uvulars clarified, it is possible to give geometries for the effluxes. Note that the elements which make up the effluxes fall into two categories; one group consisting of elements which can be specified with laryngeal features and a second group consisting of elements which are designated by placelmanner features. In the first group we have aspiration, glottalization and voicing indicated with the features [±spread glottis], [±constricted glottis] and [±voicel respectively. In the second we have nasalization indicated with the feature [±nasal], and the uvular stops and fricatives which require the structure described in (10) above. Assuming that each of the 16 effluxes may be specified positively for at most one of the laryngeal features, effluxes can be classified into four groups:

1. [−spread glottis][−constricted glottis][−voice]
2. [+spread glottis][−constricted glottis][−voicel
3. [−spread glottis][+constricted glottis][−voice]
4. [−spread glot tis][−constricted glottis][+voice]

This configuration though contains redundant information. What is of importance, is only a *positive* value of any of the laryngeal features. The negative values are the default specification and can therefore be added by a redundancy rule. This seems to be support for an analysis in terms of privative features, where 2., 3. and 4. are represented simply as [spread glottis], [constricted glottis] and [voice] respectively, while 1. is the null possibility.

1. -
2. [spread glottis]
3. [constricted glottis]

4. [voice]

Now at the same time we can assume that effluxes must also be assigned exactly one place/manner specification. This gives another four groups:

1. velar
2. uvular stop
3. uvular fricative
4. nasal

These two classifications can be intersected and represented in the form of a 4x4 matrix.

(11)

	velar	uvular stop	uvular fricative	nasal
(null)	[!] (1)	[!q] (6)	[!x] (10)	[!n̥] (15)
[spr. glott.]	[!^{h}] (3)	[!q^{h}] (8)		
[constr .glott.]	[!] (5)	[!q^{ʔ}] (9)	[!kx^{ʔ}] (12)	[^{ʔ}!n] (16)
[voice]	[!g] (2)		[g!x] (11)	[!n] (14)

also: [g!^{h}] (4) [N!G] (7) [g!kx^{ʔ}] (13)

With but three exceptions all of the 16 possible effluxes fall within the grid. Among the exceptions: the voiced uvular stop with prenasalization does not contrast with a voiced uvular stop (without prenasalization). This is exactly parallel to the non-clicked voiced uvular stop [G] which is in free variation with its prenasalized counterpart [NG]. This seems to indicate that prenasalization is not contrastive before a voiced uvular so that [N!G] can be collapsed with the non-occurring [!G] leaving only two exceptions. On the other hand there are also two combinations which do not seem to occur; the first represents an aspirated nasal [!n^{h}]. As was already noted before in the case of the voiced uvular stop, prenasalization does not seem to be contrastive when added to a voiced segment. It seems then that perhaps nasalization in general is not contrastive when added to a voiced segment. That is as in most languages something of the following type holds:

$$[\text{nasal}] \Rightarrow [\text{voice}]$$

Accepting this implication gives a problem in only one case namely, voiceless nasalized vs. voiced nasalized which would be collapsed by that principle, except under the assumption' that voiceless nasalized is actually an 'aspirated nasal' (or a nasal with spread glottis articulation). Adopting the above stated condition on nasalization immediately eliminates a whole series of potential contrasts which indeed are unattested.

The other missing articulaton on the grid is the aspirated uvular fricative *[!x^{h}]. This seems to be a phonetically motivated gap, since it would presumably be difficult to

distinguish an aspirated from a non-aspirated fricative. In general there do not seem to be aspirated fricatives among the sounds of the worlds languages.

Finally the remaining effluxes, which do not fit into the grid [g!^{h}] and [g!kx^{ʔ}] are both voiced counterparts of other effluxes. Possibly then voicing should be treated differently from the other laryngeal features, and should instead be an optional feature for any efflux, except for the nasal effluxes where it is redundant. A reorganization along these lines gives:

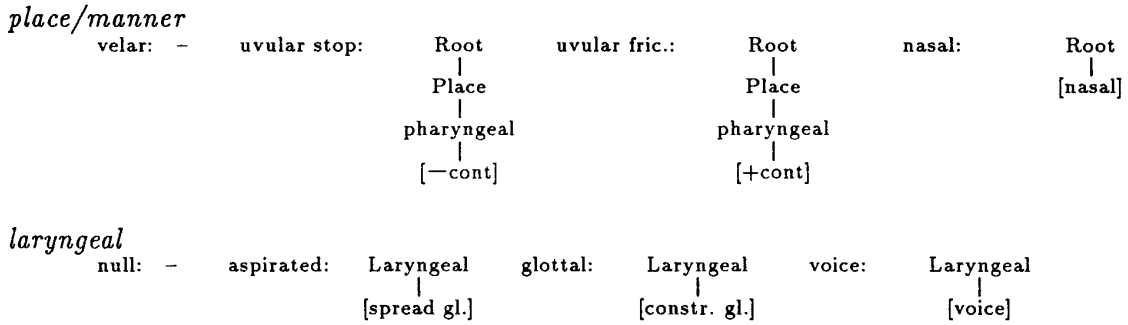
(12)

	velar		uvular stop		uvular fricative		nasal
		[voice]		[voice]		[voice]	
(null)	[!]	[!g]	[!q]	[ɴ!ɢ]	[!x]	[g!x]	[!n]
[spr.glott.]	[!^{h}]	[g!^{h}]	[!q^{h}]		-	-	[!n̥]
[constr.glott.]	[!^{ʔ}]	[!q^{ʔ}]			[!kx^{ʔ}]	[g!kx^{ʔ}]	[^{ʔ}!n]

The combinations which are still missing from this grid are perhaps accidental gaps Note for example that voiced glottalized segments do occur among the non-clicked conso· nants of !Xóõ.

The geometries for the effluxes which has been developed up to this point can now be represented as in (13).

(13) Proposed geometries for click effluxes



All effluxes can now be assembled from these parts by taking one of the geometries out of the set of placelmanner articulators and combine it together with a laryngeal feature specification and optionally with voicing. A fully specified click then adds this efflux to one of the influx geometries in (6).

2.2 Non-clicked consonants

In addition to clicks !Xóõ also has a large number of non-clicked consonants many consisting of complex articulations. They can be grouped according to their primary point of articulation as follows (T85, p 151).

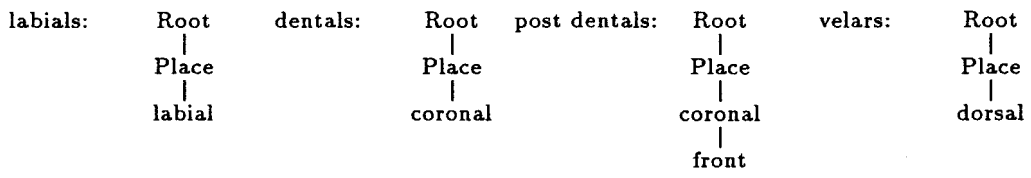
(14)

	labial	dental	post dental	velar	uvular
voiceless stop	(p)	t	ts	k	q
aspirated	(p^h)	t^h	ts^h	k^h	q^h
voiced	b	d	dz	g	(ɴ)ɢ
voiced aspirated		dt^h	dts^h		
ejected			$ts^ʔ$	$kx^ʔ$	($q^ʔ$)
voiced ejected			$dts^ʔ$	$gkx^ʔ$	
stop + x		tx	tsx		
voiced + x		dtx	dtsx		
ejected + $kx^ʔ$		$t^ʔkx^ʔ$	$ts^ʔkx^ʔ$		
voiced ejected + $kx^ʔ$		$dt^ʔkx^ʔ$	$dts^ʔkx^ʔ$		
nasal	m	n			
pre-glottal nasal	^ʔm	^ʔn			
fricative			s	x	

Here again the contrast between fricative and affricate is correlated with a contrast between plain and ejective articulation. That is ejected fricatives are realized as affricates. Further the affrication observed in the case of the primary articulation of ts and dz is a redundant feature of the place [post dental]. Labials in !Xóõ are rare and are generally restricted to loanwords. Aside from the consonants listed in the chart, /l/, /d^y/ and /n^y/ also occur, although their distribution is restricted in an interesting way. More will be said about this later.

In the same way that !Xóõ clicks can be described, the model here permits us to characterize non-clicks as well. That is just as clicks can be viewed as consisting of an influx and an efflux, !Xóõ consanants can be seen to consist of a primary articulation together with the same set of secondary articulations which make up the click effluxes. The main difference is that among the non-click secondary articulations there is no contrast between uvular stops and uvular fricatives. So that the secondary articulations for nonclicks consist of the by now familiar placelmanner articulator, one of the set plain, nasal or uvular, together with a laryngeal feature specification and an optional voice specification. The geometries for the simple consonants are:

(15)



Adding the secondary articulations gives the following combinations:

(16)

		labial		coronal		coronal		dorsal	
			[voice]		[voice]		[voice]		[voice]
plain		(p)	b	t	d	ts	dz	k	g
	[s.g.]	(p^h)		t^h	dt^h	ts^h	dts^h	k^h	
	[c.g.]					$ts^ʔ$	$dts^ʔ$	$kx^ʔ$	$gkx^ʔ$
uvular				tx	dtx	tsx	dtsx	q	(N)G
	[s.g.]	-	-	-	-	-	-	q^h	
	[c.g.]			$t^ʔkx^ʔ$	$dt\ ^ʔkx^ʔ$	$ts^ʔkx^ʔ$	$dts^ʔkx^ʔ$	($q^ʔ$)	
nasal		m		n					
	[c.g.]	'm		'n					
contin.						s		x	

A point which deserves some elaboration is the assumption that the uvular secondary articulation can be specified, as in the case of click effluxes, with a simple [pharyngeal] articulator node. This is because it is clear that at the time of phonetic realization a [pharyngeal] node which is anchored to a consonant must be realized as a uvular in !Xóõ. The segment /tx/ then is to be considered underlyingly a 'pharyngealized /t/', but its phonetic realization is as a /t/ with a uvular fricative accompaniement. In the same way we do not need to specify the fact that when a [pharyngeal] node combines with a [coronal] the resulting uvular is realized as a fricative (e.g. /tx/), while when a [pharyngeal] node is put together with a [dorsal] node the result is a uvular stop (e.g. /q/).

2.3 Vowels

The basic vowel system of !Xóõ consists of the five vowels /a/, /i/, /e/, /u/ and /o/. From this basic set the language obtains a rich set of contrasts by using length distinctions, diphthongs and secondary articulation. Since the first two cases fall out from the prosodic organization of the language, they will not be discussed until later. The secondary articulations possible on vowels in !Xóõ are nasalization, pharyngealization, glottalization and breathy voice. Further most of the cumulative combinations of these features are possible as well (T85, p 68). A complete list of the vowels of !Xóõ is given in (17).

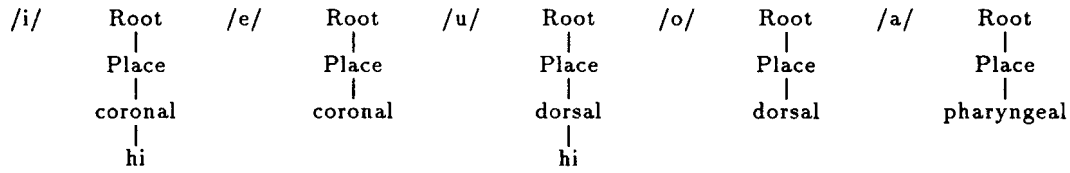
(17) Vowels

	plain					nasalized				
basic	i	e	a	o	u		ẽ	ã	õ	ũ
pharyngeal			a̱	o̱	u̱			ã̱	õ̱	ũ̱
breathy voice	i^h	e^h	a^h	o^h	u^h		$ẽ^h$	$ã^h$	$õ^h$	$ũ^h$
glottalized	$i^ʔ$	$e^ʔ$	$a^ʔ$	$o^ʔ$	$u^ʔ$	$ĩ^ʔ$		$ã^ʔ$	$õ^ʔ$	$ũ^ʔ$
pharyng. + breathy			$a̱^h$	$o̱^h$	$u̱^h$			$ã̱^h$		
pharyng. + glottal			$a̱^ʔ$		$u̱^ʔ$					
breathy + glottal			$a^{hʔ}$	$o^{hʔ}$	$u^{hʔ}$			$ã^{hʔ}$	$õ^{hʔ}$	

The most important observation here, is that pharyngealization is restricted to the back vowels /a/, /u/ and /o/. T85 (p 68) considers all the remaining gaps to be accidental.

It should by now be obvious that the geometries for the vowels of !Xóõ are constructed in the same way as those for the consonants of the language. That is, to a basic set of simple vowels secondary articulations are added. The features which make up the secondary articulations for vowels are again the by now familiar [nasal] (for nasalization), [spread glottis] (for breathy voice), [constricted glottis] (for glottalization) and [pharyngeal] (for pharyngealization). The last of these obviously has no contrast between stops and fricatives. Finally [voice] is completly predictable, that is non contrastive, and does not represent a possible secondary articulation on vowels. The geometries for the plain vowels are given in (18).

(18)



This completes the overview of the segment inventory of the language.

3. Co-occurrence restrictions

3.1 'stem' structure

While the segment inventory of !Xóõ is large the syllable structure of the language is quite simple. Only CV and CVN syllables are permitted. More interesting is that these syllables are grouped into units, which in T85 are called 'stems' since they represent the basis for the lexical items of !Xóõ. These units consist of either a heavy syllable (i.e. a syllable with a long vowel, diphthong or a nasal coda) or two light CV syllables. If we

describe long vowels and diphthongs as VV sequences, we can illustrate the stem structure of !Xóõ with the following diagram:

(19) 'stem' structure

$$C_1\ V_1 \left\{ \begin{matrix} (C_2)\ V_2 \\ N \end{matrix} \right\}$$

T85 notes that there are important distributional restrictions which apply to the stem. So although C_1 can be any click or complex consonant, C_2 is restricted to only 6 possible consonants: /b/, /d^y/, /m/, /n/, /n^y/ and /l/, and there are only two possible nasals which can appear in the N position, /n/ and /m/. The distribution facts are summarized in (20) where, following the terminology in T85, C_1 is called the stem initial, C_2 the intervocalic and N the stem final C position.

(20)

stem initial C:	clicks, complex consonants	intervocalic C:	b	d^y		stem final C:	m	n
			m	n	n^y			
				l				

What is remarkable about this is that in a language with so many consonants, there could be such an imbalance in the number of consonants which can appear in one C position compared with the others.

A similar skewing pertains to the vowels. Only the V in the first position can realize the secondary features pharyngeal, breathy voice and glottalization, while the second position can only realize nasal. So out of a total of 44 vowel contrasts, only 9 can appear in the second position. These facts are listed in (21).

(21)

V_1	V_2
pharyngeal	nasalized
breathy voice	
glottalized	
nasalized	

Another strange fact about the consonants which can appear in the intervocalic position, is the composition of that set. Several of them /l/, /n^y/ and /d^y/ do not figure among the stem initial consonants. In one case, /l/, the oddity can be reduced by noting certain alternation facts. Traill notes that /l/ can be seen to alternate with /t/ in certain situations. For instance /b/, /l/ and /d^y/ have emphatic alternants /pː/, /tː/ and /t^{y}ː/ (T85, p 165). Also words which have /l/ in dialects which permit initial /l/, have a /t/ in those dialects which do not. For example the ʘHoa and ǂHuã dialects permit initial /l/, while the Lone Tree dialect does not (Traill 1978).

(22)

⊙Hoa/ǂHua	Lone Tree	
lâaqáe	tâaqáe	‘woman’
Iē^{ʔ}àã	tē^{ʔ}àã	‘there’

Also the plural marker /-tê/ alternates with the form /-lê/ in all dialects. All this seems to indicate that /l/ can be considered to be the intervocalic C realization of /t/ (or perhaps /d/). This is relevant because it shows that the feature [lateral] is redundant, for /l/.

3.2 Back Vowel Constraint

Aside from the distribution facts, there are also many co-occurrance restrictions on cV sequences. For one there is the restriction which T85 calls the Back Vowel Constraint, which can be represented schematically as in (23).

(23)

If:	C	V	then:	C	V
	[+back]			[+back]	[+back]

This constraint is of course based on a segmental feature characterization where the [+back] consonants are the clicks, uvulars, and velars and the [+back] vowels are /a/, /u/, /o/. Note that since by far the majority of stems in !Xóõ have clicks or velar consonants initially, the net effect of this restriction is that most stems contain a back vowel. This is in fact the case: T85 (p 90) notes that 96% of all stems have a back vowel as their first vowel.

3.3 CV restrictions

A further set of restrictions cited in T85 (p 92) applies to the different types of laryngealization in !Xóõ. They are shown in (24).

(24)

C	**V**		**C**	**V**		**C**	**V**
plain	plain		aspirated	plain		ejected	plain
plain	pharyng		* aspirated	pharyng		* ejected	pharyng
plain	breathy		* aspirated	breathy		* ejected	breathy
plain	glottal		aspirated	glottal		* ejected	glottal

*	/x/	pharyng
*	/x/,/s/	breathy

Among all the potential CV sequences, the ones which systematically fail to occur have been marked here with an asterisk. The two restrictions which apply to /*x*/ and /*s*/, the only fricatives of the language, might be subsumed under the restrictions on aspirated segments, if we consider fricatives to be underlyingly aspirated.

The set of restrictions in the last column state that a consonant which is ejected, cannot be followed by a vowel which is either pharyngealized, breathy voice or glottalized. This is illustrated by the examples in (25). As a result of these restrictions the examples in (25a) are !Xóõ words, while those in (25b) are impossible.

(25)

a)	g|xáʔã	'splatter water'	b)	*g|kxʔa̰ã
	g|kxʔàã	'chase'		*gjkxʔàʰã
				*g|kxʔàʔã

All the words above are of the type CVV. The initial C in the example 'splatter water' is a dental click with a (pre-)voiced uvular fricative efflux. In all the other examples the onset is identical except for the ejection of the efflux. In 'splatter water' the vowel is glottalized. Since the onset is not ejected this is a perfectly acceptable !Xóõ word. In the case of 'chase' on the other hand the onset is ejected, but at the same time the vowel is plain, so again there is no problem. In each of the examples in (b) though the ejected onset is followed by a non-plain vowel, thus making these words unacceptable. The other restrictions are given examples in (26).

(26)

a)	!ʰòo	'hat'	but:	*!ʰo̰o
	!o̰ba ka	'stalking'		
b)	‖qa̰ã	'cold'	but:	*‖qʰa̰ã
	‖qʰàã	'tooth'		
c)	tsʰála	'rub'	but:	*tsʰáʰla
	tsàʰã	'bubble'		
d)	!qʰàa	'water'	but:	*!qʰàʰa
	qāʰa	'slyness'		
e)	xáã	'go between'	but:	*xa̰ã
				*xáʰã
f)	sâa	'go'	but:	*sâʰa

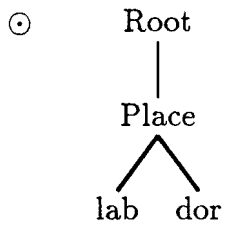
(a) and (b) both illustrate the restriction on aspirated consonants being followed by pharyngealized vowels. Similarly (c) and (d) show the cases of aspirated consonants followed by breathy voice vowels. And (e) and (f) show the restrictions on the fricatives /x/ and /s/ being followed by various vowels.

4. Towards a proper description of !Xóõ complex segments

4.1 Ordering of articulations in !Xóõ

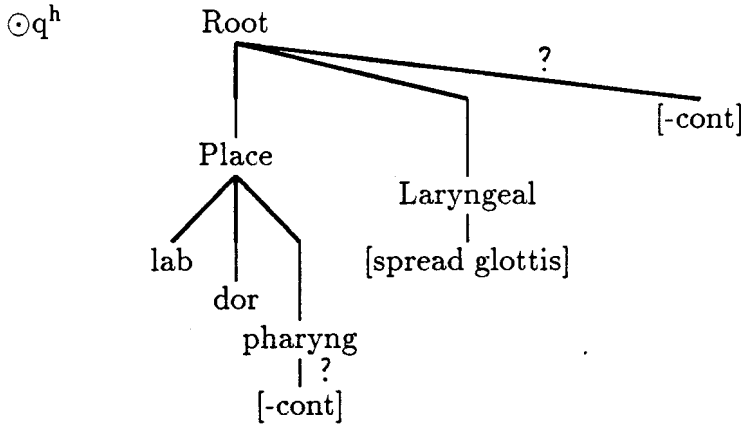
In Sagey (1986) clicks are 'complex segments' in contrast to 'contour segments', the crucial difference being that in complex segments the articulators are unordered, while in contour segments articulators on the same tier are linearly ordered with respect to each other. To characterize clicks as complex segments in this sense is appropriate since !Xóõ does not contrast labio-dental clicks with dorso-labial clicks. Similarly there is no contrast between pre-aspirated clicks versus (post-)aspirated clicks. The ordering of the articulators is redundant in !Xóõ, and in the framework under consideration redundant information need not be specified underlyingly. Sagey considers click influxes to be doubly articulated segments where one of the articulators is dorsal. The example of a bilabial click influx is shown in (27).

(27) Example of a click influx (Sagey 1986)



To this an efflux must be added so in the next exhibit we have a fully specified segment, a bilabial click with an aspirated uvular stop efflux [⊙q^h]. All these articulations are unordered.

(28) Example of a fully specified !Xóõ click



But it is clear that at the time of phonetic realization the articulators are not unordered. That is the labial closure is released slightly before the dorsal one, which in turn is released while the pharynx is still constricted. Finally the peak of aspiration follows the relaxation of the pharyngeal constriction. The important generalization here is that

for !Xóõ the ordering of the different articulations at the phonetic level is 'recessive' (also called 'regressive'), that is they move from the front of the mouth towards the back (T85, p 208). This is just what has been noted for the caucasian languages such as Kabardian, which also has large numbers of complex segments, so called 'Harmonic Clusters' (Padgett 1991). Padgett discusses this ordering and notes that such an ordering might be phonetically motivated, although as he also points out not all languages obey it. I will put this question aside for the moment and assume that in order to predict the sequence a language specific rule might be necessary (cf. Padgett 1991, p 187).

In order to determine the exact formulation of this rule it will be necessary to investigate what the proper ordering of the articulators should be. From segments such as (28) above can be deduced that [labial] must precede [dorsal], [dorsal] must precede [pharyngeal] and [pharyngeal] must precede [spread glottis]. Consideration of segments such as [!kx^{h}] show that similarly [coronal] must precede [dorsal] as well as that [pharyngeal] must precede [constricted glottis]. For the ordering of [labial] and [coronal], there is no direct evidence in !Xóõ, since there are no labio-coronal segments and in general segments involving labial are quite rare. Since the general ordering of the articulators is according to place, from the front of the oral cavity to the larynx, it can be assumed that [labial] precedes [coronal]. In the case of [constricted glottis] and [spread glottis] on the other hand such considerations are of course not possible, and one might even suspect that they are not ordered with respect to eachother. But !Xóõ does have segments which have both [sg] and [cg] articulation, among its vowels, as seen in examples such as |ũ$^{h\text{ʔ}}$u 'bird'. And as already hinted at by the transcription chosen in T85 for such secondary vowel features, the correct ordering of these two articulations, is the one where [sg] precedes [cg]. In order to clarify this point a little more needs to be said about the exact distribution of secondary vowel features.

As was noted earlier the secondary features [pharyngeal], [spread glottis] and [constricted glottis] are always associated with the vowel of the stem (T85, pp *75/86/88)*. That is in !Xóõ stems of the type C_1 V_1 (C_2) V_2 only V_1 can be underlyingly specified for any or all of the features [phar], [sg] and [cg], while for V_2 only association with the feature [nasal] is possible. Phonetic realization of the first three of these features is also only on VI. Pharyngealization, i.e. [phar], and breathy voicing, the realization of [spread glottis] on a vowel, are extended throughout the vowel and are most prominent in the middle of the vowel. As an illustration of this fact T85 suggests that a vowel sequence with pharyngealization such as [a̱i] might be rendered as [a̱a̱ai] (T85, p 76). Glottalization of a vowel is realized as an interruption in the middle of a vowel. The resulting vowel is realized as two very brief vowels surrounding a glottal stop, so that a vowel sequence with glottalization such as [a$^{\text{ʔ}}$i] would be rendered as [a$^{\text{ʔ}}$ ai]. The realization of these 3 features contrasts with nasalization, which is spread across stem vowels (and possibly an intervening consonant),

and therefore realized on both vowels. The important point here is that when a vowel is both glottalized and breathy voice, the breathy voicing which usually extends throughout the vowel ceases with the glottal constriction (T85, p 88). So in a sense the breathy voice, which is usually realized in the middle of a vowel, is 'pushed forward' onto the first half of the interrupted vowel and so realized before the glottalization. This seems to argue for an ordering of the secondary features possible on vowels, where [sg] precedes [cg].

The ordering of articulations relevant for !Xóõ, as proposed here, can now be stated formally as in (29), where X > Y is used to represent 'X precedes Y'. (The features [nasal] and [voice] are unordered.)

(29) Recessive Ordering Hierarchy (ROH)

labial > coronal > dorsal > pharyngeal > spread glottis > constricted glottis

Now the following can be stated as a principle for !Xóõ.

(30) Recessive Ordering Condition (ROC)

All articulations must obey the Recessive Ordering Hierarchy

The effect of this principle is that for a segment such as that illustrated in (28) above, the articulators, which are unordered underlyingly, must be ordered in compliance with the ROH when they are linearized, at the latest at the time of phonetic realization.

So far the discussion has assumed that clicks are to be viewed as single segments. But a question which still needs to be answered is whether they can not also, perhaps preferably, be treated as clusters. Now the fact that the articulations of complex 'segments' are ordered regressively is actually an argument in favor of their being segments as opposed to clusters, as is pointed out by Padgett (1991) in the case of the Caucasian Harmonic Clusters. This is so because if the ordering of articulations is predictable it should not need to be specified. So underlyingly the articulations should be unordered. For example if the labial click with voiceless uvular stop [⊙q] were underlyingly specified as a cluster consisting of a labial click followed by a voiceless uvular stop [⊙][q], the representation would be encoding aspects of the linear order as well as the segmental contents. This would then be predicting the existence of segments such as a uvular stop followed by a labial click [q][⊙]. The complex segment proposal does not encounter this problem since the articulations are underlyingly unordered. There can therefore be no underlying contrast between [⊙q] and [q⊙].

But a cluster analysis might still be possible under the assumption that the clusters are underlyingly unordered. A rule equivalent to the ROC would then need to be invoked to linearize these clusters before any phonological rules can apply. Such a view cannot be correct since it would still require the articulators to be ordered at the phonological level. That the articulations must be unordered in the phonology was argued for independantly by Sagey (1986) for click influxes. The argument there involves the rule discussed earlier in (5) and repeated here as (31).

(31)

$$a \rightarrow i \; / \; \left\{ \begin{array}{c} | \\ \ddagger \end{array} \right\} \_\_\_\_ i$$

Examples of this rule are seen in (32).

(32)

|ˀìi	'lover'	|ˀàbatê	pl.
|qʰíi	'buffalo'	|ʰábatê	pl.
ǂˀíi	'shoot it! (Cl. 1)'	ǂˀáasè	nominalization
ǂqʰìi	'dog'	ǂʰàbatê	pl.

The environment in which this rule occurs is between the dental and palatal clicks and the front vowel(s). Sagey argues that it is necessary to view the clicks as [coronal] segments for the rule in question. At the same time tl},ese same clicks also behave as [dorsal] (or [+back]) segments for purposes of the Back Vowel Constraint. So we see that the very same segments behave both as [coronal] and [dorsal] segments. This is only possible if they are viewed as unordered complex segments. But this same argument which Sagey applied to the click influxes extends to the full clicks, the influx-efflux complexes, as well. Among the examples which undergo the rule (31) we have examples like ǂqʰìi 'dog' and |qʰíi 'buffalo'. The clicks ǂqʰ and |qʰ have aspirated uvular stop accompaniments. Under a complex segment analysis there is no problem here, since the segment as a whole is still coronal. But under a cluster analysis the environment of this rule would be non-local.

4.2 Co-occurrence restrictions re-examined

Although the ROC was established for the purpose of determining the phonetic realization of complex segments, it also has some interesting consequences beyond this. This can best be demonstrated by looking at only part of the entire formulation. Part of the ordering propsed is given again here in (33).

(33) ROH second half

··· > pharyngeal > spread glottis > constricted glottis

This part of the ordering together with the ROC can be understood as a shorthand for the articulation sequences in (34).

(34)

[phar][phar]	*	[sg][phar]	*	[cg][phar]
[phar][sg]		[sg][sg]	*	[cg][sg]
[phar][cg]		[sg][cg]		[cg][cg]

That is it says that among all the possible pairs formed by the three articulators [phar], [sg] and [cg] , the 3 combinations which are stared here are unacceptable. In the case of single segments this is not further interesting since if a segment contains both the features [phar] and [sg] for example, they will simply order properly as [phar][sg] in order to fulfill the constraint. This is why an aspirated uvular stop will be realized as [q^h] and not *[^{h}q]. But what if the two articulators are in different segments? Since the two segments are necessarily ordered, the two articulators which are anchored to these segments will be equally linearly ordered and unable to reorder in order to fulfill the ROC. So for instance in a case where the two articulators [phar] and [sg] are features of a consonant and an adjacent vowel respectively, the result will be a sequence of a uvular consonant followed by a breathy voice vowel such as in q$\bar{a}^h$a 'slyness'. Since this sequence is of the type [phar][sg] it obeys the ROC and is therefore acceptable. But in the case where [sg] is a consonant feature and [phar] a vowel feature, this will result in a sequence consisting of an aspirated segment followed by a pharygealized one, such as in the non-existant form *[!^{h}a̱a]. Such a sequence is of the type [sg][phar], which is one of the pairs ruled out by the ROC. But this is also exactly one of the CV sequences which do not occur in !Xóõ. Similarly the other two sequences in the list in (34), which are ruled out by the ROC, are *[cg] [phar] and * [cg][sg]. These two sequences translate into the CV combinations, ejected consonant followed by pharyngealized vowel, and ejected consonant followed by breathy voice vowel. These are again two of the non-occurring CV sequences of !Xóõ.

Let us therefore look at the co-occurrance restrictions and compare the situation. The restrictions are repeated here in (35) from (24).

(35)

	C	V		C	V
*	aspirated	pharyngeal	*	ejected	pharyngeal
*	aspirated	breathy	*	ejected	breathy
			*	ejected	glottal

And in addition also the sequences:

(36)

	C	V
*	/x/	pharyngeal
*	/x/, /s/	breathy

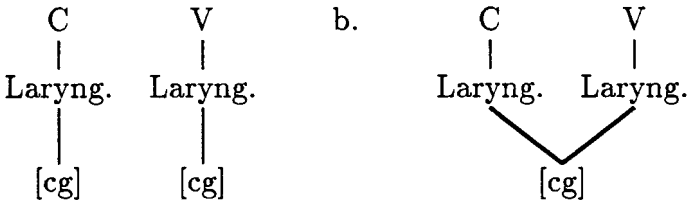
As was noted earlier there is alot of evidence from !Xóõ as well as from other languages to support treating fricatives as aspirated segments. The last two restrictions then simply turn out to be special cases of the restrictions above on aspirated consonants. Now if the list of restrictions is translated into feature terms they can be written as:

(37)

* [sg][phar]	* [cg][phar]
* [sg][sg]	* [cg][sg]
	* [cg][cg]

We can now compare (37) with (34). Three of these restrictions * [sg][phar], *[cg][phar] and *[cg][sg] are exactly the ones discussed above and are therefore predicted by the ROC. The remaining two restrictions are *[sg][sg] and *[cg][cg]. These can be accounted for by assuming that the OCP is applicable to laryngeal features in !Xóõ. Actually it is really double linking of laryngeal features which needs to restricted in !Xóõ. To illustrate this consider the example of an ejected consonant followed by a glottalized vowel, a sequence which does not occur in !Xóõ. This would need to be represented either as in (38a.) or (38b.).

(38)



The representation in (38a.) is ruled out because the OCP does not permit adjacent identical autosegments. But this still leaves the representation in (38b.) as a possibility. If such doubly linked laryngeal features are prohibited then the unavailability of the sequences *[sg][sg] and *[cg][cg] is explained. This together with the ROC accounts then for all the CV restrictions on secondary articulations.

But so far only part of the ROH has been considered. There is another half to the ordering, namely:

(39) ROH first half

labial > coronal > dorsal > ⋯

As before this can be expanded to (40):

(40)

[lab][lab]	* [cor][lab]	* [dor][lab]
[lab][cor]	[cor][cor]	* [dor][cor]
[lab][dor]	[cor][dor]	[dor][dor]

Again we find that the ROC predicts the unavailability of three sequences. The point of interest is now what the meaning of these restrictions are. The first two are *[cor][lab] and * [dor][lab]. If these are again interpreted as CV sequences, this would predict that labial vowels may not follow coronal or dorsal consonanants. If labial vowels include /u/ and /o/, then this is clearly not the case. There are countless examples of such sequences:

tùu ‘people’ or !õo ‘knife’. But since /u/ and /o/ are first of all back vowels, and do not contrast with any unrounded, and therefore non-labial, vowels they can be considered to be underspecified for rounding, that is labial. This leaves the language without any segments which could be relevant for these restrictions and they become vacuous. The third restriction is *[dor][cor]. Again interpreted as a CV sequence this says that a dorsal consonant cannot be followed by a coronal vowel. Since the coronal vowels are /i/ and /e/, this turns out to be the Back Vowel Constraint. The [+back] vowels in !Xóõ are /u/, /o/ and /a/, and these all have a dorsal articulator (or possibly a pharyngeal articulator in the case of /a/). Sequences of [dor] [dor] or [dor][phar] are of course not a problem for the ROC, but if a consonant with a dorsal articulator, a velar, uvular or click, which constitute the [+back] consonants in T85, is followed by either /i/ or /e/ the result will be the impossible sequence *[dor][cor]. The Back Vowel Constraint can thus be seen to be a direct consequence of the ROC.

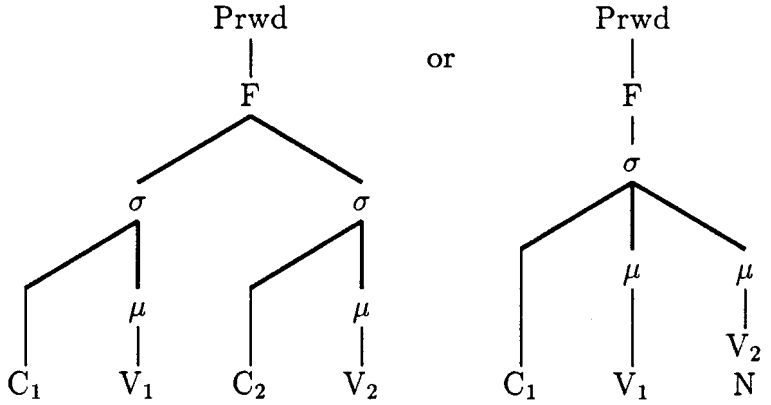
A point which has so far been glossed over is that there is a large class of sequences which is also predicted to be bad by the ROC. These are all those instances where one out of the class of [lab], [cor] and [dor] follows anyone of the class consisting of [phar], [sg] and [cg]. That is the ROC predicts that *[cg][dor], *[phar][dor], *[sg][cor] etc. are unacceptable sequences. This would be a major difficulty, since in the strictest interpretation it would mean that nothing at all could follow a glottalized segment. This is obviously a ridiculous result. But before rejecting the ROC out of hand, an alternative should be considered. The reason why this does not necessarily cause a problem, is that there is a distinction in !Xóõ between primary and secondary articulation, and that the two behave separately with respect to the ROC. So in a case such as ⊙ˀóo ‘be stuck’, the sequence [cg][dor], resulting from the glottalization of the click followed by the back vowel /o/, does not violate the ROC because the glottalization associated with the consonant is secondary, while the dorsal articulation is the primary articulation of the vowel. That the distinction between primary and secondary articulation with respect to recessive ordering is necessary is also suggested by Padgett (1991) in the case of the Harmonic Clusters of Kabardian. Padgett notes that Harmonic Clusters obey recessive ordering, if secondary articulation — labialization and palatalization in this case — are ignored (Padgett 1991, p 185). O’Herin (1988) notes for Abaza that certain spreading rules can be simplified if they are seen as applying only to secondary articulation. There is also independant evidence in !Xóõ, that primary and secondary articulation need to be treated separately. This has to do with the restrictions on the structure of the !Xóõ stem discussed above in 3.1.

T85 and Traill (1978) attempt to describe the stem in terms of the notion lexical item. There is a strong correspondance between what constitutes a stem in !Xóõ and the lexical items of the language. But it is clear that the stem is not the limit for lexical items, neither upper nor lower, since there are examples of shorter items, mostly grammatical

morphemes, as well as longer 'bi-stemic' lexical items. The later are not always obviously compounds. Typical examples are names e.g., Bōlo.‖xáo, borrowed words e.g., tón.tì, from English 'donkey' and a few other cases such as kā.‖nû^{ʔ}be 'stork' (the dot is used here to symbolize the stem boundaries). It seems clear that the stem described here is equivalent not to a morphological or semantic unit, but to a prosodic unit. Since the possible prosodic shapes of the stem are CVV, CVC or CVCV, the prosodic unit relevant here seems to be a bimoraic foot.

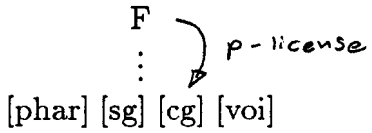
The restrictions on the stem are that only C_1 can be a complex segment, i.e. a click, or a non-click with any kind of secondary articulation, while C_2 can only be one of the six consonants /b/, /d^{y}/,/l/, /m/, /n/ and /n^{y}/. (N can only be /m/ or /n/.) Similarly only V_1 can have any of the secondary features pharyngealization, breathy voice or glottalization. V_2 can only be plain or nasalized. All this suggests that the first mora is in some sense more important. The stem of!Xóõ therefore seems to be the moraic trochee, one of only three types of foot permitted in the system argued for by Hayes (1987) and McCarthy & Prince (1986). The stem can therefore be represented as follows:

(41) StemStructure



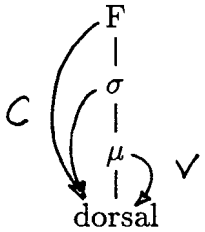
In a moraic trochee the first mora can be considered to be the head of the foot. The important restriction on the !Xóõ foot is that secondary articulation typically the features [phar], [sg] and [cg] can only be realized on the head of the foot. Actually [voi] should probably also be included here, although it is irrelevant for ROC purposes. This is because [voi] is only contrastive on the foot initial segment C_1. Voicing in the intervocalic position (C_2) is predictable, since only voiced segments appear there. This enables a formulation where the C_2 position permits only simple and nasal segments, which is the same as the V_2 position. Now it is possible to give a more precise formulation of the distribution of the secondary articulations in terms of prosodic licensing.

(42) Prosodic licensing of secondary features (Itô 1986, Goldsmith 1990)



With this formulation the bulk of the complex segments are now correctly excluded from the second mora of the stem. Among the segments which are no longer licensed to appear in the C_2 position are /tx/, /!^{h}/, /q/, /⊙kx$^?$/, etc. But the structure is still somewhat too permissive, since it would still not exclude /k/ (that is /g/ once the redundant voicing kicks in) and the plain clicks ⊙, !, |, ǂ and ‖ from the C_2 position. There would be a number of ways to solve this problem, but since Prosodic Licensing has been suggested for secondary features, it could be employed here as well. All the segments which are barred from the intervocalic position have dorsal as their main articulators. So again it might be assumed that dorsal would need to be p-licensed by the foot. But there are of course also dorsal vowels and these may freely appear in V_2 as well as in V_1. Here it will be assumed that all vowel primary articulators are licensed by the mora. Onsets are licensed by the syllable, but the special status of dorsal follows from the fact that it cannot be licensed by the syllable alone but needs to be licensed by the foot also. The formulation can be seen below.

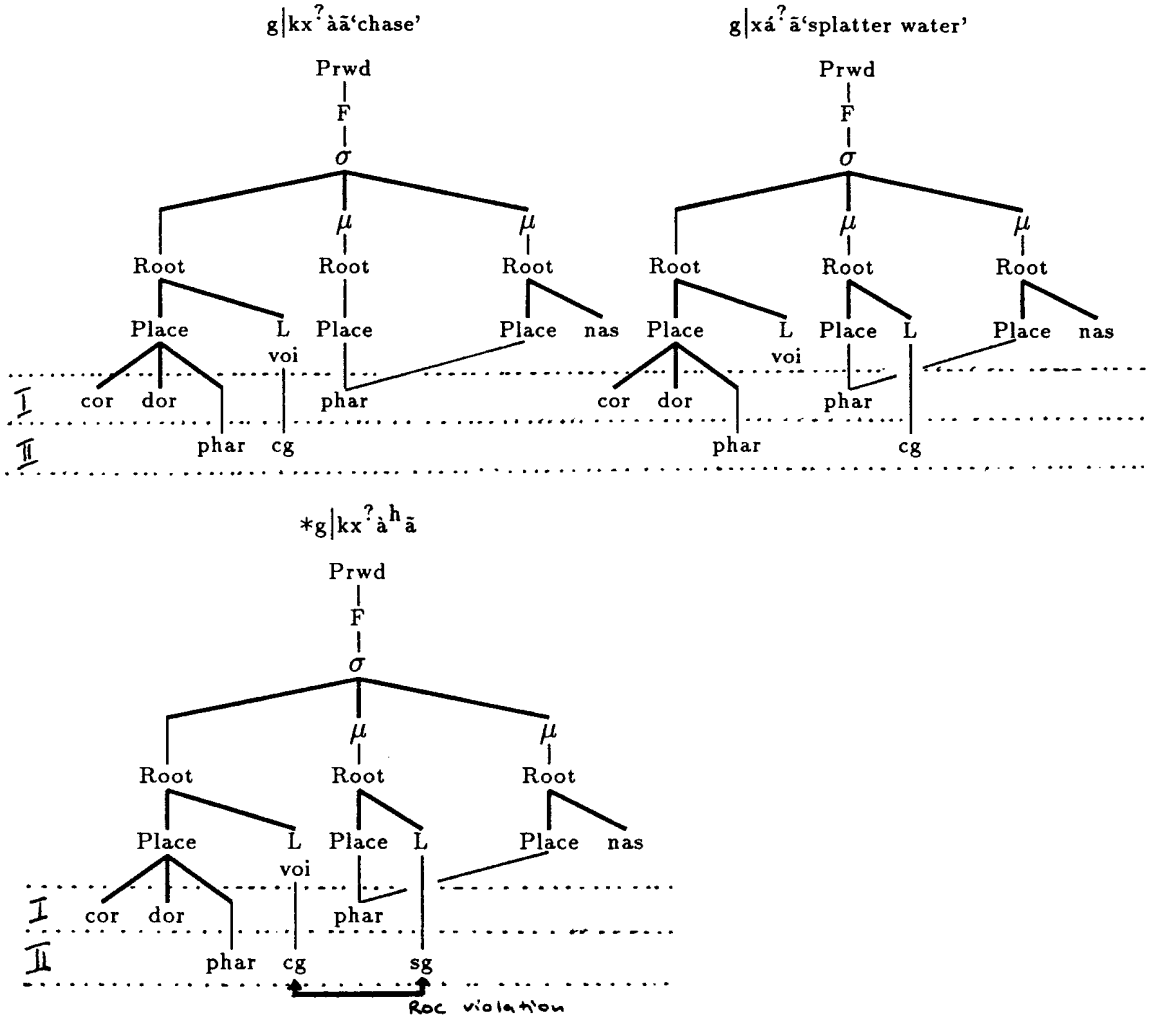
(43) p-licensing of dorsal



This proposal in a sense captures an idea, proposed in T85 and Traill (1978), that clicks, uvulars and velars are 'too strong' to appear in the intervocalic position. Here they are 'too strong' in the sense that they require double licensing.

What follows from this discussion, is that secondary features can now be characterized as those which are licensed *only* by the foot, while primary features are those which are licensed by either the syllable or the mora. It is now possible to account for the contrasts noted earlier in (25). The structures for those forms can be seen here in (44).

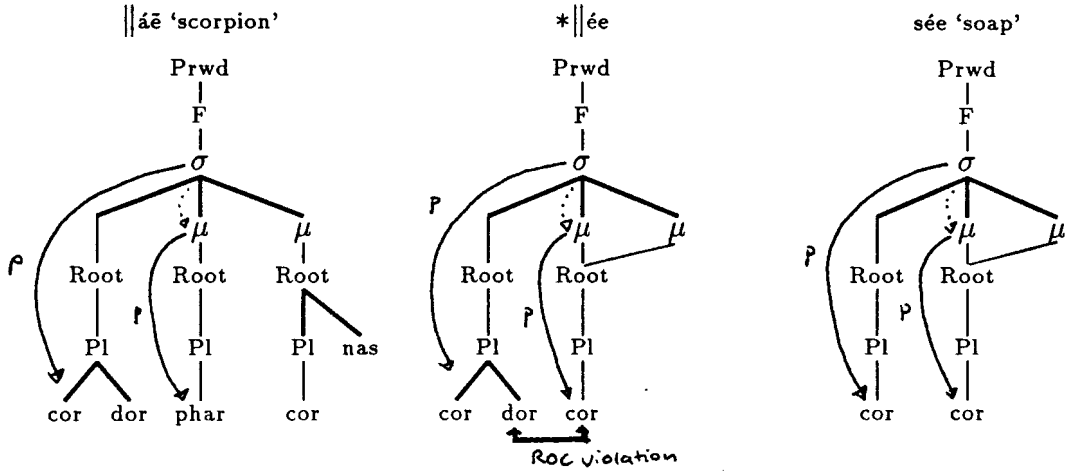
(44)



The examples in (44) all consist of single foot; monosyllabic words. The features have been separated into two 'bands' marked I and II. I 'is the band for primary articulation and II is the band for secondary articulation. In each of the three cases the articulations on the first band consist of a sequence [cor][dor][phar]. Since this is perfectly in accordance with the ROC, there is no problem. On the second band we have three different situations. First in the case of g|kx?àã 'chase' there are two secondary features [phar] and [cg], both linked to the onset position. Since they are linked to the same segment they are free to order, so they line up in accordance with the ROC. In the second case g|xá?ã 'splatter water' there are again the same two secondary features, but this time linked to different segments. Because they are linked in the order [phar][cg], which is permissable under the ROC, there is no problem. Finally the third case is the ungrammatical *g|kx?à^hã. Here there are three secondary features, [phar] and [cg] linked to the onset while [sg] is linked to the vowel. The first two are again free to order and line up as [phar] [cg] which is okay, but the [sg] feature is linked to the next segment, thus producing the sequence [cg][sg], which is a violation of the ROC. This rules out the last form as a possible word of !Xóõ.

Another case to consider is the three way contrast between the examples ǁáẽ ‘scorpion’, sée ‘soap’ and the nonexistant form *ǁée.

(45)



Since the vowel sequence in ǁáẽ ‘scorpion’ is /ae/, that is [phar][cor], it would seem at first that there should be a problem with the ROC. But unlike secondary features which are licensed by the foot, the primary features are licensed by the mora in the case of the vowels and by the syllable in the case of the onsets. Since the first mora is the head of the syllable, it is part of the domain of the syllable. The feature [phar] is linked to and licensed by the first mora and therefore indirectly by the syllable, which itself licenses the onset features [cor] and [dor]. These three should all obey the ROC, as they indeed do. The feature [cor] in the second mora is licensed by that mora and since the second mora is not the head of the syllable, there is no further licensing relationship. Since [cor] is the only feature in that mora, it trivially obeys the ROC. The nonexistant form *lIee provides a situation where the feature [cor] is linked to the first mora and is therefore indirectly licensed by the syllable. But since there is a [dor] segment in the onset, a [dor][cor] sequence within the domain of the syllable results, which violates the ROC. The last case see ‘soap’ shows a nearly similar case to the previous ungrammatical one. The difference here is that there is only a [cor] feature in the onset. Since the features licensed by the syllable are all [cor], there is no obviously no ROC violation and the form is therefore acceptable.

From all of this can be seen how the ROC and prosodic licensing of features interact to account for the various co-occurrence restrictions of the language.

Some problems still remain though. The feature [nasal] although unordered as stated above can still have a certain influence. If it is in the same segment as [constricted glottis], they become ordered as [consticted glottis][nasal], that is as a preglottalized nasal. But then the segment can be followed by a vowel which is [pharyngeal] or [spread glottis] in seeming violation of the ROC. For example:

(46)

ʔǂn̪à̰ũ ‘rightside’

ʔ!nàʰn ‘lay horizontal’

A similar problem occurs in:

(47)

!n̥ə̰̂m ‘evade attack’

If voiceless nasal is considered to be [spread glottis] the sequence voiceless nasal followed by pharyngealized vowel will result in a feature sequence [spread glottis][pharyngeal] which is again in violation of the ROC.

5. Conclusion

This analysis shows that the co-occurrence restriction in !Xóõ can be seen to be the result of the interactions between several principles

- recessive ordering
- prosodic licensing
- a notion ‘head of a prosodic constituent’
- the OCP

Although at first glance this might seem like quite an array of principles to explain a handful of restrictions, most of these have been well motivated elsewhere, and have been assumed to hold across all languages. This account then gives support to these principles in a somewhat more unusual context. Among these principles the one that sticks out as being of seeming lesser generality is the condition on recessive ordering. Most languages clearly do not obey this constraint in any observable way. It is interesting to note though that the only other languages where recessive ordering seems to play some role are also languages with large consonant inventories.

References

Chomsky, N. and M. Halle (1968) *The Sound Pattern* of *English,* Harper & Row, New York.

Clements, G. N. (1985) “The geometry of phonological features,” *Phonology Yearbook* **2**, 225–252.

Goldsmith, J. A. (1990) *Autosegmental* and *Metrical Phonology,* Basil Blackwell, Oxford. Hayes, B. (1987) “A Revised Parametric Metrical Theory,” *NELS* **17,** 274–289.

Itô, J. (1986) *Syllable Theory in Prosodic Phonology,* Doctoral Dissertation, University of Massachusetts.

Itô, J. and R. A. Mester (198?)

Itô, J. and R. A. Mester (1993) “Licensed Segments and Safe Paths,”

Ladefoged, P. and A. Traill (1980) “The phonetic inadequacy of the phonological specifications of clicks,” *UCLA Working Papers in Phonetics* **49**, 1–27.

Maddieson, I (1984) *Patterns* of *Sounds,* Cambridge University Press.

McCarthy, J. (1988) “Feature Geometry and Dependancy: a review,” *Phonetica* **43**, 84–108.

McCarthy, J. and A. Prince (1986) *Prosodic Morphology,* ms., University of Massachusetts and Brandeis University.

O’Herin, B. (1991) “Secondary Articulations and Feature Geometry,” *Phonology* at *Santa Cruz* **2**, 83–94.

Padgett, J. (1991) *Stricture in Feature Geometry,* Doctoral Dissertation, University of Massachusetts.

Sagey, E. (1986) *The representation* of *features and relations in non-linear phonology,* Doctoral Dissertation, MIT.

Snyman, J. W. (1970) “An introduction to the !Xu (!Kung) language [by] J. W. Snyman,” *Communication* of *the University* of *Cape* Town *School* of *African Studies* **34**, Balkema academic and technical publications, Balkema (A.A.), Cape Town.

Traill, A. (1979) “The !Xóõ Strength Hierarchy,” in J. W. Snyman ed., *Bushman* and *Hottentot linguistic studies: papers* of *seminar held* on 29 *October* 1977, University of South Africa, Pretoria, 1–38.

Traill, A. (1985) “Phonetic and phonological studies of !Xóõ Bushman,” *Quellen zur Khoisan-Forschung; Bd*. 1, H. Buske, Hamburg.

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