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The vowel system of G|ui

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1. Introduction

G|ui is a poorly documented Khoisan language (West Kalahari Khoe group, Khoe family) spoken in Botswana. This paper describes important aspects of G|ui vowels. (See Nakagawa (1996) for the G|ui consonant system.) Concerning G|ui vowels, Voßen's (1997) extensive comparative work on the Khoe family provides preliminary descriptive information, such as a phonemic sketch of G|ui vowels (p.110), observations on the distribution of vowel features in Khoe languages (pp. 139-141), and example words found in a comparative Khoe vocabulary in the appendix (pp. 413-511). In the course of a more precise and detailed description below, I will discuss Voßen's (1997) relevant descriptions.

This paper consists of six sections. The next section identifies the vowel inventory and classifies the attested vowel phonemes of G|ui. The following three sections describe important phonetic details of the plain vowels (section 3), the nasal vowels (section 4) and the pharyngealized vowels (section 5.). The final section of this paper will deal with distributional constraints of vowels in G|ui. They include a type of constraint, the so-called Back Vowel Constraint, which Traill (1985) first used for describing !Xóõ and suggested its validity for a wider rage of Khoisan languages. I will discuss the applicability of the Back Vowel Constraint to G|ui.

2. Vowel inventory

G|ui has five plain (non-nasal and non-pharyngealized) vowels, /i e a o u/, three nasal vowels, /ĩ ã ũ/, and two pharyngealized vowels, /a̰ ṵ/, underlyingly. These ten distinct vowels can be classified as in Table 1 in terms of three conventional features for vowel quality, i.e. height, backness and lip-rounding, and two additional features, i.e. nasality and pharyngealization. The vowels are exemplified with ten words in

Table 2. Important phonetic details of each vowel will be fully described below.

Table 1 A classification of G|ui vowels

	i	e	a	o	u	ĩ	ã	ũ	a̱	u̱
high	+	–	–	–	+	+	–	+	–	+
low	–	–	+	–	–	–	+	–	+	–
back	–	–	+	+	+	–	+	+	+	+
round	–	–	–	+	+	–	–	+	–	+
nasal	–	–	–	–	–	+	+	+	–	–
pharyngeal	–	–	–	–	–	–	–	–	+	+

Table 2 Words illustrating the G|ui vowels

Plain	Nasal	Pharyngealized
/ĩ/ "tree"	/hm̃m̃/ "do"	
/ʔéẽ/ "it"		
/ʔáã/ "that"	/ʔãã̃/ "dress"	/ha̱é/ "hole"
/ʔóõ/ "inside"		
/ʔúú/ "send"	/hŭṹ/ "just"	/tsu̱m̃/ "wild vegetable"

Voßen (1997:110) interpreted the rounded pharyngealized vowel as /o̱/ instead of /u̱/. As will be described in section 5, however, this vowel patterns with /u/ in terms of diphthongization, and therefore should be phonologically interpreted as the pharyngealized counterpart of /u/. In addition to the ten vowels, Voßen (1997:110) reported two vowel phonemes, namely, one plain /ɛ/ and one pharyngealized /e̱/. These two additional vowel phonemes, however, have not been attested in any G|ui dialectal varieties which I have investigated.

Voßen's (1997:appendix) comparative Khoe vocabulary records six words with /ɛ/ (p.434, 479, 481,487, 492, 502).

Table 3 compares Voßen's and my transcriptions for these six words. (Note that in his notation long vowels and short vowels are neutralized and transcribed as short

vowels as cited in (1), (2) and (3) in Table 3.) In my observation, the vowel /ɛ/ in these six words falls into either (i) the phoneme /e/, which tends to be phonetically slightly opened by the influence of /a/ or /a̱/ in the preceding syllable, as in (1), (2), (3) and (4), or (ii) the phoneme /a/ which tends be phonetically slightly fronted by the influence of the following /e/ or the following coronal sonorant /r/ or /n/, as in (5) and (6) in the table. Regarding the phoneme /e̱/, its examples are not given in Voßen (1997). Therefore, this phoneme cannot be verified. I conclude G|ui vowel inventory includes neither /ɛ/ nor /e̱/.

Table 3 The six words with /ɛ/ in Voßen (1997)

	Voßen (1997)		Nakagawa	Gloss
(1)	|x?ɛ̀	(p.434)	/k|qχ'áɛ̄/	"fall"
(2)	||x?ɛ́	(p.502)	/k||qχ'áɛ̀/	"meet"
(3)	kx?ɛ́	(p.487)	/qχ'áɛ̄/	"cry"
(4)	da̱bɛ́	(p.481)	/da̱bɛ̄/	"salt"
(5)	||x?ɛ́dì	(p.492)	/k||qχ'árì/	"scorpion"
(6)	ǂxɛ́ná	(p.479)	/kǂχáná/	"a cold in the nose"

3. Plain vowels

The common five plain vowels /i e a o u/ are illustrated in Figure 1, in which the F1 and F2-F1 values of these vowels spoken by five speakers are plotted. ("F2-F1" means the difference between F2 and F1.) As reflected in this acoustic vowel space, /a/ can be regarded as [+back], together with other two back vowels, /u/ and /o/, as opposed to the remaining [–back] vowels /i e/. As will be seen in section 6.2, the feature specification with [+/– back] is necessary for the constraint on a vowel occurrence, which is called the Back Vowel Constraint.

As shown in Figure 1, the five plain vowels are not evenly distributed in the acoustic vowel space, especially with respect to the vowel height, /e/ and /o/ (particularly the latter) being closer to /i/ and /u/ than the typical mid position. This uneven distribution agrees with the auditory impressions that /e/ is close to /i/ and /o/ to /u/.

As will be described in the next section, because of this phonetic detail of /e/ and /o/, the high nasal vowels /ĩ/ and /ũ/ tend to sound more like nasalized counterparts of /e/ and /o/ than nasalized counterparts of /i/ and /u/. Evidence for interpreting these two nasalized vowels as /ĩ/ and /ũ/ as opposed to /ẽ/ and /õ/ will be presented in section 4. The rounded vowel /u/ shows an uncommon allophonic realization. This vowel is always pronounced as a diphthong before the coda /m/ or /n/. The diphthong is characterized by (i) a transitional tongue-body lowering, and (ii) a transitional lip-movement from rounded to unrounded. This diphthong would be transcribed as [wa] or [u͡a] in the IPA (henceforth just [wa]). This diphthongal realazation of /u/ is illustrated with a spectrogram of /k|úm̃/ [k|wám̃] "suck" shown in (1) of Figure 2, which shows a clear raising of the first formant toward the latter half of the vowel, together with raisings of higher formants. This formant-raising corresponds to the transitional movements of the lip and the tongue-body. It should be noted that this diphthong bears only a single tone occuring with one mora, accordingly, it is regarded as forming not two morae but one mora. The duration of the diphthong [wa] is always much shorter than a sequence of two vowels, and similar to the duration of the monophthong. This is illustrated in Figure 2, where the duration of [wa] /u/ in (1) /k|úm̃/ is approximately the same as that of [a] /a/ in (2) /k|áḿ/ "sun", being approximately 190 ms, and this is approximately half of the duration of a sequence of the two vowels [ũã] /ũã/ (approximately 380 ms) in (3) /k|ũ̃ã̀ m̀/ "a child's".

The diphthong [wa] alternates with [u] in accordance with the change of the syllabic structure. In the formation of a compound verb the first element is followed by the so-called juncture morpheme /-a/ when it has CVN structure (Nakagawa 2006). This changes the coda of the first element into the onset of the following syllable. Accordingly, /u/ is realized as the monophthong [u] (e.g. /k|úm̃/ [k|wám̃] "rub" → k|úm̃-a mã̀ã̀ [k|úmā mã̀ã̀] "rub for someone").

The diphthongization of /u/ before a coda is not reported in other Khoisan languages, even in G||ana, the genetically and structurally closest Kalahari Khoe language, in

which [wa] preceding the coda in G|ui corresponds to [u] (e.g. [k|wámˉ] "rub" in G|ui; [k|úmˉ] "rub" in G||ana).

At this stage it is not clear to me why only G|ui exhibits this diphthongization.

4. Nasal vowels

Out of the five plain vowels, three peripheral vowels /i, a, u/ are underlyingly combined with the feature nasality, forming /ĩ ã ũ/. This three nasal vowel system is predominant among Khoe family languages, according to Voßen's (1997:141) comparative observation.

As I mentioned earlier, however, in G|ui the height of the two nasal high vowels, /ĩ ũ/, are usually auditorily lower than that of the plain high vowels /i u/ and near to the height of the mid vowels /e o/. They may be phonetically transcribed as [ẽ õ]. This auditory height reflects in F1 values of these vowels. Figure 3 compares F1 mean values (shown with standard deviations) among /ũ/, /u/ and /o/ and those among /ĩ/, /i/ and /e/. (Five speakers. Three tokens for each speaker.)

The F1 mean values of /ũ/ and /ĩ/ are much higher than those of /u/ and /i/, and near to those of /o/ and /e/. This agrees with the relative auditory heights of the two nasal vowels.

Table 4 The natural classes /i u ĩ ũ/ and /a ã e o/ involved in the compound verb construction. Examples in (1) to (4) involve /a/-suffixation, and those in (5) to (8) involve /r/-insertion. Note /r/ is realized as [n] between the nasal vowels

Citation form		gloss	first element of a compound verb	
(1)	/k!^{h}ûĩ/	"pierce"	→	/k!^{h}ûĩ-a/ [k!^{h}újã]
(2)	/χãũ/	"be ashamed"	→	/χãũ-a/ [χãwã]
(3)	/g‖ãĩ/	"be constipated"	→	/g‖ãĩ-a/ [g‖ájã]
(4)	/tsáũ/	"make"	→	/tsáũ-a/ [tsáwã]
(5)	/k!áã/	"lose"	→	/k!á-r-ã/ [k!árã]
(6)	/k!ʔáã/	"know"	→	/k!ʔá-r-ã/ [k!ʔánã]
(7)	/k!^{h}áẽ/	"sting"	→	/k!^{h}á-r-ẽ/ [k!^{h}árẽ]
(8)	/k|òõ/	"finish"	→	/k|ò-r-õ/ [k|òrõ]

Morphophonologically, however, it is clear that the two nasal vowels behave in the same way as /i u/, not as /e o/. In the compound verb construction the first element is marked by the suffix –/a/ (i.e. the so-called "juncture morpheme") when the second vowel in a root (V2) is /i u ĩ ũ/ (Nakagawa 2006). This is illustrated in (1) to (4) in Table 4. In contrast, the first element is marked by means of /r/-insertion (realized as [r] or [n]) when V2 is /a ã e o/ as illustrated with (5) to (8) in Table 4. This indicates that /ĩ ũ/ form a natural class with /i u/, and not with /e o/.

5. Pharyngealized vowels

The two pharyngealized vowels, unrounded /a̱/ and rounded /u̱/, occur only in the first vowel of phonological roots (V1).

Pharyngealized vowels of G|ui are characterized by a raising of F1 and F2 and an optional feature of auditorily noisy voice quality. Figure 4 compares /a/ and /a̱/ by using a minimal pair (/g‖àrm̄/ "like" and /g‖a̱rm̄/ "carry on the shoulder slantwise") spoken by three male speakers. The first formant of /a̱/ is clearly higher than that of /a/ for all the speakers. The second formant is also raised toward the mid part of the vowel, although often less clearly. The noisy voice quality is used by some speakers. It is illustrated in /a̱/ of speaker (3), in which there are irregular vibrations seen particularly in F1 and F2.

It should be pointed out that /u̱/ is regularly realized as a diphthong, i.e. [w̱a̱] or [u̱͡a̱], which involves a certain transient lip-rounding articulation from rounded to unrounded, just like the diphthongization of /u/ before a coda, /m n/, (see section 3). Also like the diphthongized /u/, this diphthong always bears a single tone, and is, therefore, regarded as monomoraic.

Figure 5 illustrates /u̱/ compared with /u/ by using a minimal pair /g!úī/ "snare rope" and /g!ú̱ī/ "bully". Unlike the left panel showing relatively level F1 and F2 in /u/,

the right panel shows the vowel /u̯/ involves a remarkable raising of F1 and F2 toward the end of /u̯/. This formant raising of F1 and F2 is in common with that seen above for /a̯/. This acoustic feature of pharyngealization is probably enhanced by the lip movement in case of the rounded pharyngealized vowel.

6. Distributional constraints on vowels

Finally, this section describes two types of distributional constraints concerning C-V co-occurrence found in G|ui. One type constrains the occurrence of pharyngealized vowels, and the other type concerns the Back Vowel Constraint, under which term Traill (1985:89-92) first described this phenomenon for !Xóõ.

6.1. Constraints on pharyngealized vowels

There are two constraints involving pharyngealized vowels, as abbreviated in (1) and (2).

(1)	*C'V̯
(2)	*CqV̯

C' stands for an ejective consonant whether it is an ejective click, a single ejective non-click, or an ejective occurring as a second element of clusters. Cq stands for a uvular consonant whether it occurs as a single non-click uvular consonant or as a second element of the cluster. V̯ stands for a pharyngealized vowel.

The constraint in (1) rules out the sequence of an ejective and a pharyngealized vowel. If this constraint is assumed to be phonetically motivated, it might presumably reflect a coarticulatory difficulty of the increasing pharyngeal pressure involved in C' and the pharyngeal constriction involved in V̯. It is suggestive that (1) does not apply to the sequence of a click cluster with the glottal plosive occurring as a second element of a consonant cluster, i.e. /k|ʔ/, /k!ʔ/, /k‡ʔ/ or /k‖ʔ/, followed by a pharyngealized vowel, there being fourteen words with such a sequence (note that these click clusters does

not involve an increasing pharyngeal pressure required for ejective sounds). The similar constraint is involved in a set of C-V constraints attested in !Xóõ (Traill 1985: 92). At this stage, however, it is not known whether there are any languages with C'V̰ sequences in the world's languages. In order to test the adequacy for this phonetic explanation, a wide-ranged cross-linguistic investigation concerning C'V̰ sequences must be carried out in future research.

The constraint in (2) disallows the sequence of a uvular sound and a pharyngealized vowel. This constraint implies that the distinction between pharyngealized and non-pharyngealized vowels is neutralized after the uvular sound, and the unmarked non-pharyngealized vowel occurs in this context. This neutralization may presumably be explained by the acoustic effect that the pharyngealization and the uvular sound have in common, namely the raising of the first formant of the vowel. Figure 6 illustrates the acoustic feature shared by the uvular consonants and the pharyngealized vowels. Compared with the vowel /a/ following a non-uvular sound in (1), the pharyngealized vowel /a̰/ in (2), and the vowel /a/ following a uvular consonant in (3) have the raised first formant. The F1 value in the mid of the vowel is about 700 Hz for (1), about 990 Hz for (2), and about 950 Hz for (3). The pharyngealization of the vowel in (2) and the co-articulatory effect of the uvular sound in (3) similarly raise the first formant. This acoustic effect may be responsible for making the difference between V and V̰ less distinct.

6.2. The Back Vowel Constraint in G|ui

In G|ui there is a set of two constraints concerning the occurrence of [–back] vowels. It is observed that a [–back] vowel does not occur immediately following a uvular consonant, as abbreviated in (3), and immediately following an apical (i.e. alveolar or lateral) click, as abbreviated in (4).

(3)	*Cq V[–back]
(4)	*!/‖ V[–back]

Note that Cq represents a non-click uvular consonant, i.e. /q ɢ q^h q' qχ' χ/, whether it occurs as an independent consonant or as a second element of the cluster. Here V[–back] stands for a [–back] vowel, i.e. /i e ĩ/, and "!/‖" stands for an apical click (whether simple or complex).

This set of two constraints can be regarded as the realization of the so-called Back Vowel Constraint, which can be found in other Khoisan languages, such as !Xóõ (Traill 1985) and , Ju|'hoansi (Miller-Okhuizen 2000). In this section I will first deal with (3) and (4) separately so that the phonetic property of (4) may be transparent, and then will compare the set of (3) and (4) with the varieties of the Back Vowel Constraint attested in !Xóõ and Ju|'hoansi.

It should be noted that constraint (3) applies in the case where Cq is the second element of a consonant cluster (whether the cluster is of a click cluster or a non-click cluster, i.e. /tχ/, /tsχ/, /tqχ'/ or /tsqχ'/).

Constraint (4) states that a [–back] vowel cannot immediately follow an apical click. This does not apply to a [–back] vowel immediately following a laminal (i.e. dental or palatal) click. In fact there are about 120 words with a laminal click immediately followed by a [–back] vowel. It would therefore be expected that constraint (4) reflects the phonetic nature of the anterior closure of apical (as opposed to laminal) click articulation.

The release of the anterior closure in the apical clicks involves the more lowered tongue-front and tongue-middle parts than in the production of the laminal clicks. Figure 7 shows the tongue shape of the four clicks prior to the anterior release with the tongue shapes of the vowels [i], [e] and [a] in !Xóõ (taken from Traill 1985:115, Figure 27). As described in Traill (1985:116), in the suction for the apical clicks the front and middle parts of the tongue are away from the tongue positions for [i] and [e], whereas the tongue positions for the laminal clicks are near from those for [i] and [e].

It can be assumed that the tongue positions for the four clicks in G|ui are essentially the same as in !Xóõ. The difference in tongue positions between the apical and the

laminal clicks in G|ui is reflected in spectrograms of four G|ui words shown in Figure 8. Each of the words has /k!/, /k‖/, /kǂ/ or /k|/ as the initial consonant which is followed by the vowel /a/. A clear difference between the first two words with the apical clicks and the other two words with the laminal clicks is in the formant transitions of the vowel.

The apical clicks in (1) and (2) do not show clear F1 lowering or F2 raising, and the transitions are relatively short (about 45 ms). This indicates that the tongue position immediately after the release of the apical clicks is similar to the [+back] vowel /a/. In contrast, the laminal clicks in (3) and (4) show remarkable F1 lowering (with the locuses around 300 Hz and 400 Hz, respectively) and F2 raising (with the locuses around 1900 Hz and 1600 Hz, respectively), and the transitions are relatively long (about 60-80 ms). This indicates that the tongue positions immediately after the release of the laminal clicks are relatively similar to those of front vowels. In summary, in the production of the apical clicks, the front and middle parts of the tongue are lowered to the extent that the articulation of the following front vowels would be less easy. This relative articulatory difficulty may be reflected in constraint (4).

As mentioned earlier in this section, with the term of the Back Vowel Constraint (henceforth BVC) Traill (1985) proposed a single constraint in !Xóõ which partly overlaps with constraints (3) and (4) in G|ui. He claimed that the BVC is valid for all Khoisan languages given certain language-specific amendments (Traill 1985:91). It is therefore interesting to examine how the BVC can be applicable to G|ui.

In !Xóõ the vowel following a [+back] consonant must be a [+back] vowel, as he schematically expressed as (5) (Traill 1985:90).

(5)

If:	C1 [+back]	V1
then:	C1 [+back]	V1 [+back]

The BVC summarized in (5) is transparent in the sense that C1 and V1 share the same feature [+back]. For the purpose of a comparison with (3) and (4), however, I re-state the constraint in (5) in a different form as in (6). Note that V[–back] in (6) stands for a [–back] vowel as in (3) and (4).

(6) * C[+back] V[–back]

C[+back] in (6), i.e. the [+back] consonants, include non-click velar consonants, uvular consonants (Cq), and all the clicks (either apical or laminal, and of whatever series). As is clear from a comparison of the set of constraints in (3) and (4) with the constraint in (6), the difference between them is in the behavior of the non-click velar consonants (henceforth indicated as "Ck") and the laminal clicks of the non-cluster series (henceforth indicated as "|/ǂ"). The constraint in (6) implies that neither Ck nor |/ǂ can be immediately followed by a [–back] vowel. In contrast, the set of constraints in (3) and (4) implies that both |/ǂ and Ck can be immediately followed by a [–back] vowel. G|ui has seventeen words with Ck followed by a [–back] vowel and about 120 words with |/ǂ followed by a [–back] vowel, as exemplified in (7).

(7)

/kì/	"today-past (tense marker)"
/kè/	"because (conjunction)"
/kérē/	"turn"
/k|ĩĩ/	"song"
/k|éé/	"wildebeest"
/k|ébá/	"carry/wear on the head"
/kǂĩĩ/	"call"
/kǂéē/	"ear"
/kǂébū/	"bundle"

It is important that there is no evidence to regard the [–back] vowel following the

[+back] consonant in these words as derived from an underlyingly [+back] vowel: these [–back] vowels do not alternate with any [+back] vowels in G|ui morphology. In G|ui, therefore, the BVC cannot be applicable to either |/ǂ or Ck, and can only be applicable to the cases in (3) and (4). As long as |/ǂ and Ck are underlyingly specified as [+back], the BVC stated in terms of (5) does not work out for G|ui as such, and requires an additional sub-classification of the [+back] consonants into two classes, i.e. the class to which the BVC applies and the one to which it does not. In the remainder of this paper, in order to explore the sub-classification of the [+back] consonants, I will deal with another variety of the BVC attested in Ju|'hoansi by Miller-Ockhuizen (2000). In discussing the characteristics of G|ui in the variation of the BVC in the three Khoisan languages, I will hypothesize an implicational hierarchy of the [+back] consonants in terms of the BVC.

Miller-Ockhuizen's (2000:313-315) description of the BVC of Ju|'hoansi can be summarized as follows: the BVC cannot be applicable to |/ǂ but is applicable to Ck, !/‖ and Cq. Table 5 compares the three varieties of the BVC found in !Xóõ, Ju|'oansi and G|ui. As shown in this table, the difference among the three varieties of the BVC concerns the behavior of ǂ/| and Ck.

Table 5 A cross-linguistic comparison of the BVC. Cq stands for the uvular consonants; "!/‖" stands for the apical clicks; Ck stands for the non-click velar consonants; "ǂ/|" stands for the laminal clicks; "+" indicates that the BVC applies, and "–" indicates it does not

	Cq_	!/‖_	Ck_	ǂ/|_
!Xóõ	+	+	+	+
Ju|'hoansi	+	+	+	–
G|ui	+	+	–	–

Miller-Ockhuizen (2000:313) accounts for the observation that ǂ/| is not subject to the BVC in Ju|'hoansi by interpreting laminal clicks as "front" (implying [–back]) clicks as opposed to the "back" clicks (i.e. apical clicks). Since her proposed classification

of "front clicks" vs. "back clicks" is not merely language-specific to Ju|'hoansi, she further attempts to extend this idea to the interpretation of !Xóõ. She lists sixteen !Xóõ words in which ǂ/| is followed by an underlyingly [–back] vowel as violations for the BVC, and argues that these sixteen words are substantial enough to conclude that ǂ/| is not subject to the BVC also in !Xóõ (pp.311-312).

In G|ui there are more substantial (about 120) words with ǂ/| followed by an underlyingly [–back] vowel, and therefore this aspect agrees with Miller-Ockhuizen's proposal. However, G|ui has seventeen words with Ck followed by an underlyingly [–back] vowel. Note that Ck is regarded as back consonants (i.e. [+back] consonants) in Miller-Ockhuizen (2000). The seventeen words can be regarded as substantial to conclude that the BVC does not apply to Ck. As long as Ck is regarded as back consonants, the classification of the "front vs. back" clicks is not adequate for stating the BVC in G|ui.

The comparison of the BVC between the three languages has revealed that there are three classes in the [+back] consonants which show cross-linguistically different applicability of the BVC. As shown in Table 5, Cq and !/|| are subject to the BVC in all three languages, Ck is subject to the BVC in ! !Xóõ and Ju|'hoansi but not in G|ui, and |/ǂ is subject to the BVC only in !Xóõ (except for the sixteen words according to Miller-Ockhuizen 1999). From this observation I hypothesize that there is an implicational hierarchy of the [+back] consonants in terms of applicability of the BVC, as illustrated in (8).

(8) Cq and !/|| > Ck > |/ǂ

This hierarchy expresses implicational relations between the three classes, namely if |/ǂ is subject to the BVC, then the other classes are all subject to the BVC, and if Ck is subject to the BVC, then Cq and !/|| are subject to the BVC. In this sense, Cq and !/|| is higher in the hierarchy than the other two classes, and Ck is higher than |/ǂ.

In order to test this hypothesis, a wide-ranged Khoisan cross-linguistic investigation will have to be carried out in the future study. At this stage, my preliminary research has shown that in G||ana (the Kalahari Khoe language genetically closest to G|ui) neither Ck nor |/ǂ is subject to the BVC while Cq and !/|| is subject to it, just like the case in G|ui, and that judging from notations of the entries in Visser's (2001) dictionary, Naro (another Kalahari Khoe language) seems to have the same type of the BVC as Ju|'oansi, with three exceptional words with Ck followed by V[–back] (pp. 28, 35 and 41). These observations agree with the hypothesized hierarchy in (8).

A residual problem is how to interpret the three classes of [+back] consonants in terms of phonological features. This will be a topic in future research.

7. Summary

In this paper I have dealt with essential aspects of G|ui vowels. The topics include identifications of the vowel phonemes, their classification in terms of features, descriptions of their important phonetic details, and two types of distributional constraints on vowels, i.e. a set of two constraints on pharyngealized vowels, and another set of two constraints on back vowels which is a realization of the so-called Back Vowel Constraint found widely in other Khoisan languages.

It should be pointed out here that the two types of constraints both involve the class abbreviated to Cq. The definition of Cq, namely the uvular consonants /q ɢ q^h q' qχ' χ/ whether they occur as single consonants or as second elements of consonant clusters, is based on my interpretation of the non-click stop clusters and the click clusters as sequences of plain stop/click followed by uvular or glottal consonants. Under a different interpretation, therefore, the vowel constraints would be stated in a different manner.

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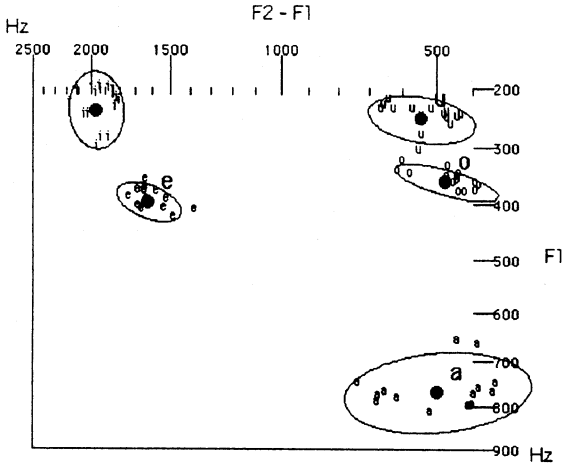

Figure 1 F1 and F2-F1 values of /i e a o u/ in G|ui.
"F2-F1" means the difference between F2 and F1.

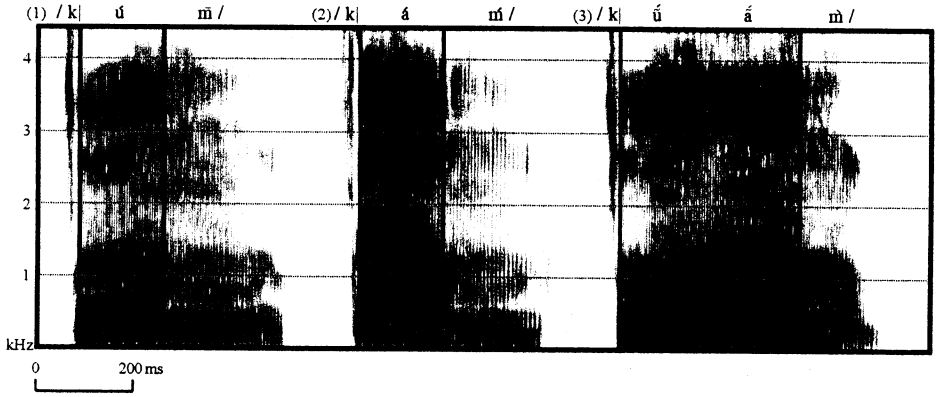

Figure 2 Spectrograms of (1) /k|úm̃/ [k|wám̃] "suck", (2) /k|áḿ/ [k|áḿ] "sun", and (3) /k|ű á̋ m̀/ [k|ű á̋m̀] "a child's" pronounced by KEX.

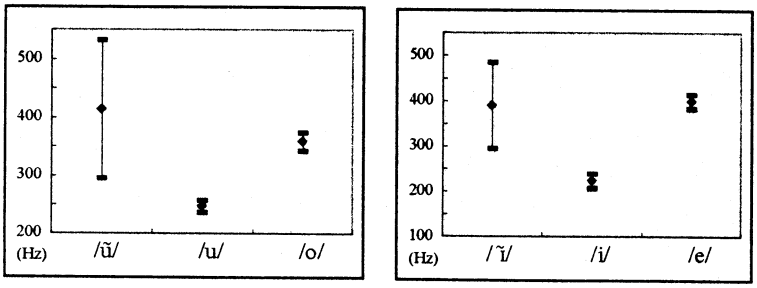

Figure 3 F1 mean values of /ũ/ and /ĩ/ compared with those of /u o/ and /i e/. The mean values are indicated with the lozenges, with standard deviations indicated with the rectangles.

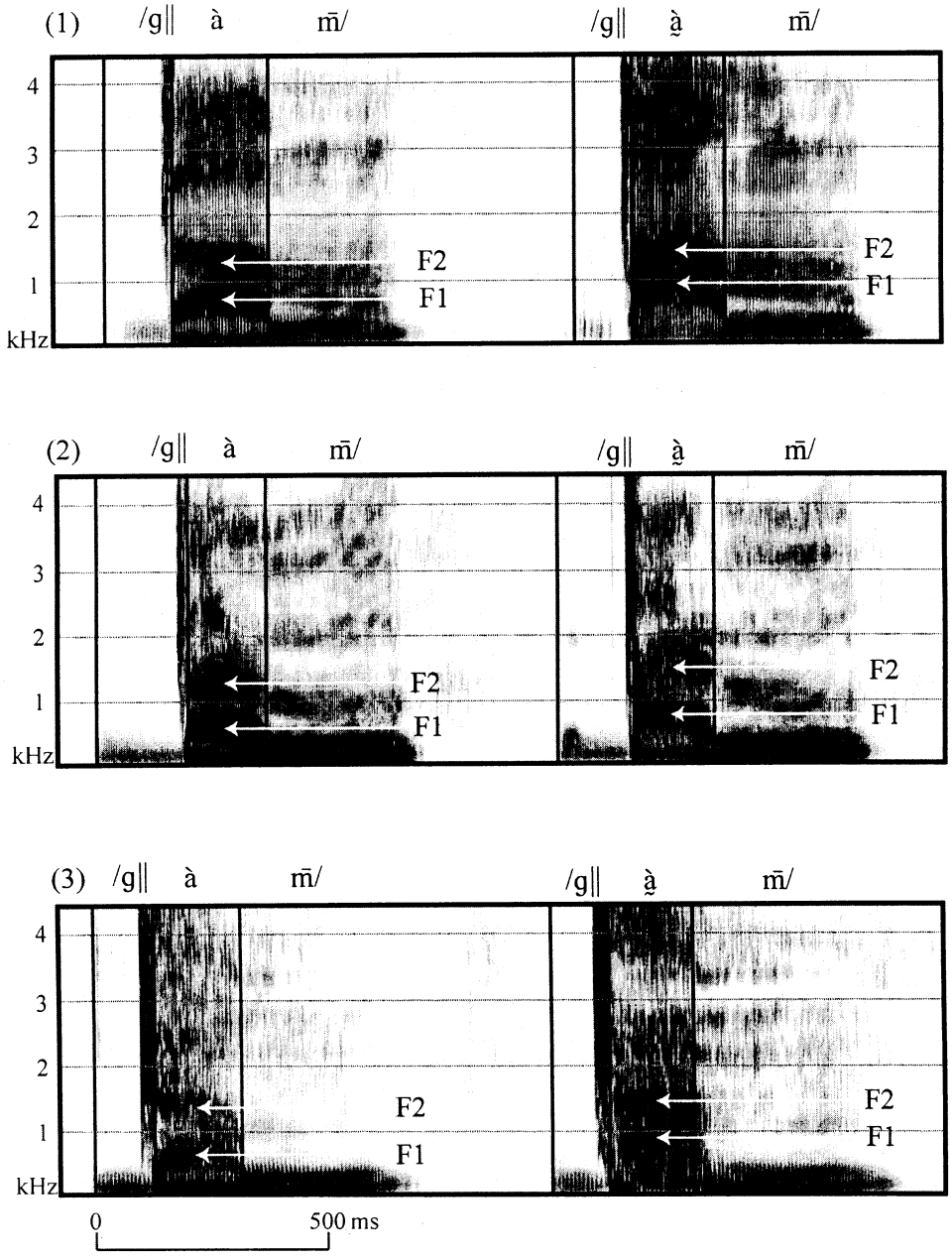

Figure 4 A comparison between /a/ and /a̰/. Panels (1) to (3) show the minimal pair /g‖àmn̄/ "like" /g‖a̰mn̄// "carry on the shoulder slantwise" spoken by (1) NOS, (2)HLS and (3) TSB, respectively. F1 and F2 are indicated with arrows.

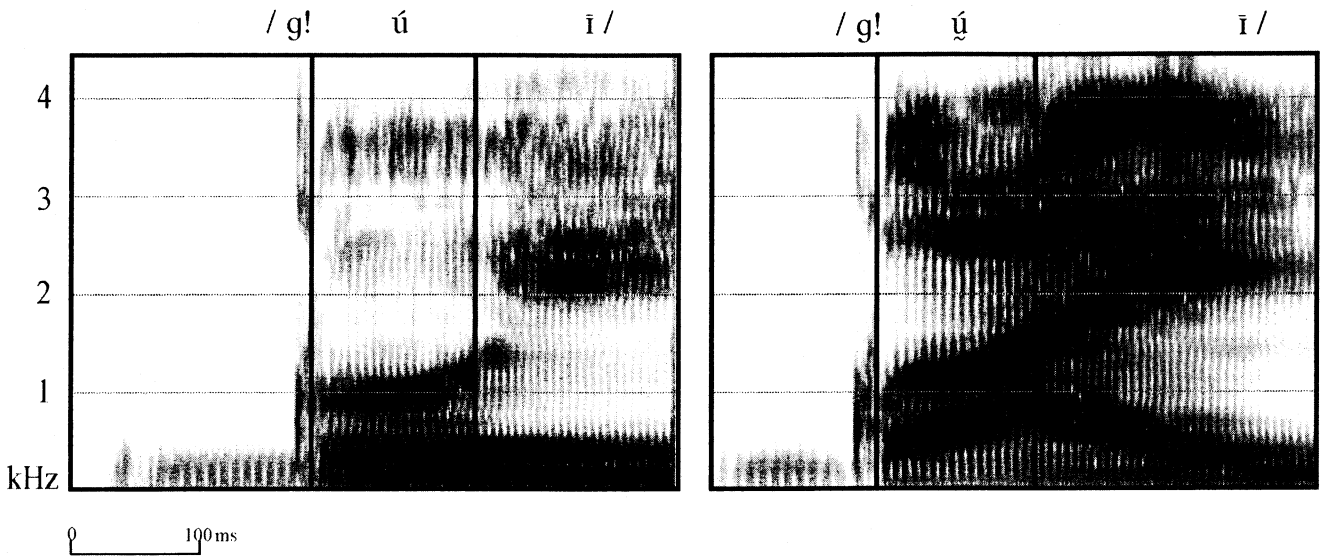

Figure 5 Diphthongization of /ụ/. Spectrograms of the minimal pair, /g!úī/ "snare rope" (in the left panel) and /g!ụ́ī/ "bully" (in the right panel), spoken by speaker NOS are shown for comparison between /u/ [u] and /ụ/ [wa̰].

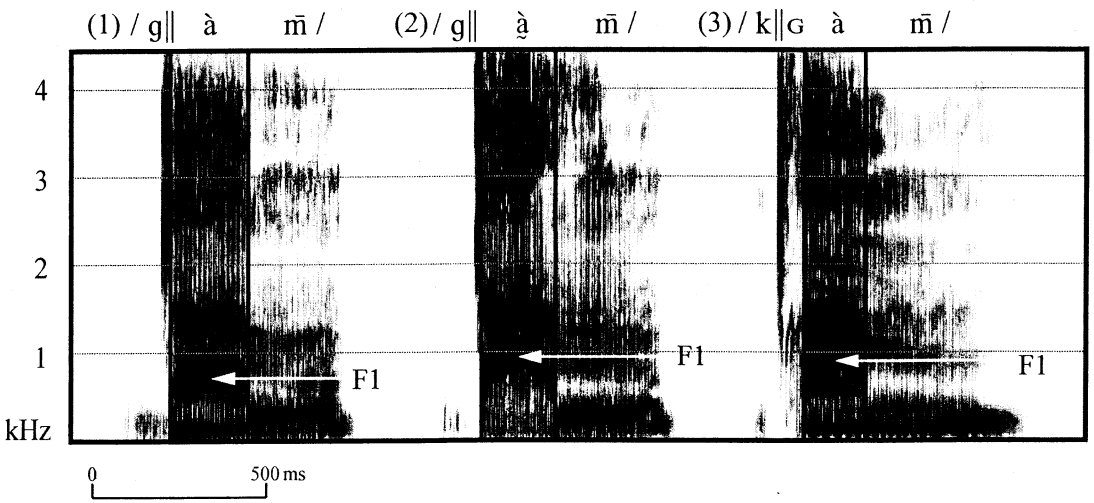

Figure 6 Spectrograms of the three words (1) /g‖àm̄/ "like", (2) /g‖a̱m̄/ "carry on the shoulder slantwise" and (3) /k‖Gàm̄/ "slimy" pronounced by NOS. The first formant (F1) is indicated with arrows.

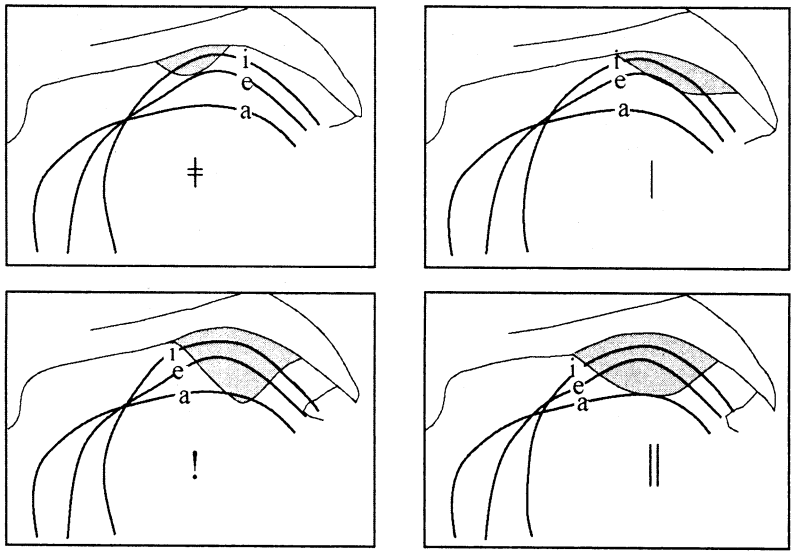

Figure 7 Tongue positions for the suction cavities of the four clicks in !Xóõ prior to the release (shaded area) with the tongue positions of the vowels [i e a] superimposed. (Based on Figure 27 in Traill 1985:115.)

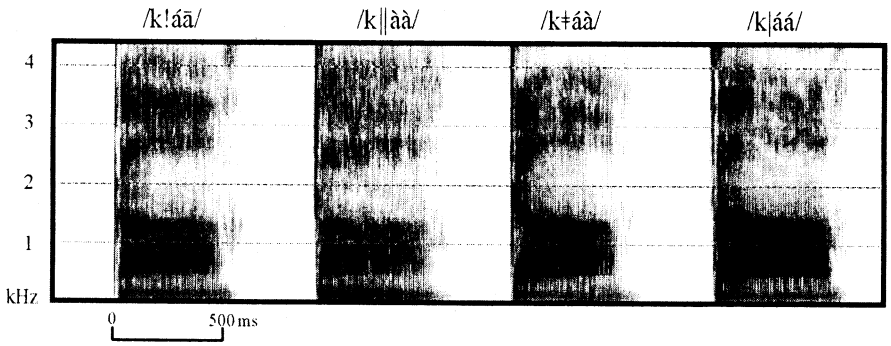

Figure 8 Spectrograms of four words illustrating click-vowel transitions, pronounced by speaker NOS. The words are /k!áā/ "lose", /k‖àà/ "black korhaan", /kǂáà/ "fill a hole", /k|áá/ "skin (verb)".

グイ語の母音体系

中川　裕

この論文は，コイサン諸語コエ語族西カラハリ・コエ語群のひとつであるグイ語の母音体系の重要な側面を記述する．まず，先行研究の解釈を検討しながら一次資料の分析結果に基づき，すべての母音音素を同定する．そして，その音素的対立に関与する特徴を設定し，それぞれの母音の重要な音声学的詳細を記述する．また，グイ語の母音に観察される２種類の音韻制限を分析・解釈する．さらに，その制限の一つを，他のコイサン諸語に認められる，いわゆる「奥母音制限」と比較検討し，コイサン諸語の奥母音制限の類型を探るため，コン語（南コイサン語族）とジュツォアンシ語（北コイサン語族）で報告されている「奥母音制限」との通言語比較を行い，制限に関わる子音類の階層に関する仮説を提案する．