To appear in *Proceedings of the International Symposium "Hunter-gatherers in transition: Language, identity, and conceptualization among the Khoisan"* . Cologne: Rüdiger Köppe Verlag.

Towards A Unified Decompositional Analysis of Khoisan Lexical Tone

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1. Introduction

Khoisan languages are spoken mainly in Namibia and Botswana, and are most well-known for their expanded consonant inventories. However, the tonal properties of Khoisan are also very interesting. All Khoisan languages have four tone levels. Different analyses have been proposed for the tone bearing unit, and the domain of tonal phenomena. Traill (1985) has proposed that !Xóõ has four different phonological contour tones which associate to the word. This analysis is based on his claim that !Xóõ has contour tones on monomoraic words, and the fact that four separate level tonemes predict sixteen tonal patterns, but only four of these are attested. He also claims that the contour tones on monomoraic words cannot be decomposed into a sequence of level tones, since there is a phonetic fall in pitch which only occurs on the edge of the second mora, never at the edge of the first. Haacke (1992) argues for a decompositional analysis of Khoekhoe tone, and shows that monomoraic words in that language which have contour tones can be traced to bimoraic words historically. Ju/'hoasi does not have contour tones on monomoraic forms at all. It does have severe restrictions on allowed tonal contours, which I will show follow a pattern. Thus, the Ju/'hoasi tonemes are clearly all level tones, which combine in some circumstances to form derived contour tones, and there are no phonological unit contour tones. I will show that !Xóõ tonal patterns can also be interpreted as level tones, with their surface contours being due to a phonetic word edge effect. It is possible that this edge effect might turn out to be phonological and be tied to the intonational system, but there is no current evidence for or against such an approach. I will propose an optimality theoretic synchronic analysis of Ju/'hoasi tonology, which will also be applied to !Xóõ tonology. The main difference is that all moras are tonally specified underlyingly in !Xóõ , but Ju/'hoasi has some underlyingly toneless moras. The tonal data in this paper comes from Dickens (1994), but I also take into account facts mentioned in Snyman (1975), and some of my own observations from listening to Snyman's (1970) cassette tapes.

2. Basic Tonal Properties of Ju/'hoasi

Ju/'hoasi has four distinct tone levels, as shown in (1) below:

(1) Tone levels in Ju/'hoasi
(Dickens, 1994 based on Snyman, 1975)

SH (Super High)	a̋
H (High)	á
L (Low)	à
SL (Super Low)	ȁ

The word type in Ju/'hoasi is severely restricted, so that only CV, CVV, CVm and CVCV word types are found. CVV words contain long vowels or diphthongs, and [m] is the only coda consonant allowed. There are seven different possible tone patterns, four of which are sequences of level tones, as well as two rising tones, and one falling tone. Assuming that the tone bearing unit is the mora, if Khoisan tones are contour units, then we would expect contour tones on monomoraic words. However, if tone units in Ju/'hoasi are single level tones which combine with each other to form contours, then we expect only to find contour tones on bimoraic forms. The data in (2) below shows that the level tone analysis makes the correct prediction, since contour tones only occur on bimoraic words. The full range of patterns found on each word type is shown in (2).

(2) Tonal Patterns and Their Realization on Different Word Types

CV:	bá	'father'	tzi̋	'outside'
	cà	'sweet potato'	bȍ̤	'porcupine burrow'
CVm:	cóm	'genital organ'	ŋ!a̋ŋ	'inside'
	g|àm	'cheek'	ŋ|ȍm	'medicine'
CVV:	gúí	'salt'	|ʔ^{h}a̋ű	'tree branch'
	n‡òè	'vulture'	n!ȁ̤ȍ̤	'bow'
	bȁ̤à̤	'stick game'	dshàú	'wife, woman'
CVCV:	g!árú	'drum'	zànȉ	'the last-born'
	zȁhȁ	‘saw'	g!ȁnȉ	‘root'
	kàqé	'marula'	córà	'smoke'

It is important to note that the coda [m] does not bear tone in the above examples, as witnessed by the fact that the CVm word type acts like other monomoraic words having CV structure with regards to tone. They do not carry contour tones.

Elderkin (1989) suggests that only L and H tones are underlying, and the two extreme tones (SH and SL) may be derived by rule due to interaction between tone and segmental influences. His analysis gives a lot of insight into the deep relationship between tone, consonant type, vowel height and phonation type in Khoisan. I will not discuss these effects here, but from my experience in the field and with listening to Snyman's (1970) cassette tapes, I find that there is not a constant relationship between these factors. For example, prevoiced aspirates in the language usually correlate with following SL tone, but there are some words where this is not true. There are some words which have H tones following voiced aspirates. This is a very interesting phenomena since in these cases, the voiced portion of the click contains implosion, presumably to strengthen the cues for voicing in absence of the tonal cue. Traill (1985) makes a similar observation regarding the absence of a one to one correlation between tone and other factors such as consonant type and phonation type in !Xóõ. These correlations are nonetheless very strong, and need to be examined in great detail before the tonal systems of these languages can be fully understood.

3. Basic Tonal Properties of !Xóõ

!Xóõ tonology is similar in some respects to Ju/'hoasi tonology, but there are some major differences which need to be accounted for. As with Ju/'hoasi, !Xóõ only has four tone levels, but Traill (1985) claims that the basic tonal units are contours, and cannot be decomposed into sequences of level tones. The four tonal patterns found on words are shown in (3) below:

(3) Traill's Contour Unit Tones for !Xóõ (Traill, 1985, 1994)

HF (High Falling)	á
MF (Mid Falling)	â
M (Mid level)	ā
LF (Low Falling)	à

As with Ju/'hoasi, !Xóõ has four possible word types. These are CV, CVV, CVm, and CVCV. A contour unit tone analysis correctly predicts that contour tones can occur on monomoraic words, while a decompositional analysis predicts that only level tones can occur on monomoraic forms. The main difference between Ju/'hoasi and !Xóõ is that Traill's contour tone units can occur on monomoraic words in !Xóõ where they cannot in Ju/'hoasi. This fact bears out the predictions of a contour unit tone analysis. The four tone patterns and their realization on different word types is shown in (4) below:

(4) The Four Word Types in Ju/’hoasi

CV:	té	'adverbial morph'	tê	'plural suffix'
	ūh	'second person pl.'	sà	'verbal formative'
CVm:	tám	'to say it, mean'	ʘûm	'sleep (n.)'
	ǁāhm	'freckle, mole'	ǂqòm	'to hold down'
CVV:	ǀqúũ	'white person'	tâa	'a San person'
	!ōo	'knife'	sòo	'medicine'
CVCV:	!úla	'quiver'	ǂâbe	'a Mudkgalagadi'
	ǀgāna	'leaf'	dt^{h}àba	'to flutter'

This is Traill's primary reason for positing contour tone units. Traill argues further that contour tones on bimoraic forms cannot be decomposed into sequences of level tones, with each of the level tones being phonetically realized as contours because this would predict that each mora should have a contour tone. Traill’s contour unit analysis predicts that the pitch shape is the same regardless of whether there is one mora, or two moras. He shows that the pitch shape of bimoraic forms give evidence for a phonological unit contour analysis, since bimoraic pitch shapes have a falling edge only at the right edge of the second mora as shown in (5)(a), rather than at the right edge of both moras as shown in 5(b) in accordance with a contour unit analysis.

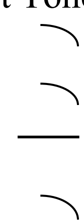
(5) (a) Predictions of Contour Unit Tone Analysis

HF (High Falling) [ ]

MF (Mid Falling) [ ]

M (Mid level) [ ]

LF (Low Falling) [ ]



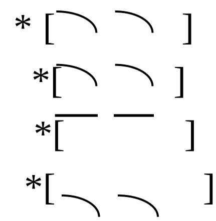
(b) Predictions of Level Tone Analysis

HF (High Falling)

MF (Mid Falling)

M (Mid level)

LF (Low Falling)



However, Traill fails to discuss a third likely alternative, which is that !Xóõ contour tones are composed of sequences of level tones, as shown in (6) below, but there is an additional phonetic effect at the edge of words.

(6) !Xóõ Level Tone Analysis with Phrasal Tone

HF (High Falling)	SH
MF (Mid Falling)	H
M (Mid level)	L
LF (Low Falling)	SL

This alternative accounts for the fact that a falling pitch occurs at the right edge of both monomoraic and bimoraic words just as well as the contour unit analysis does. In fact, I argue that this alternative is better, since it allows for a decompositional approach to !Xóõ tonology which makes it more similar to the other Khoisan languages, Ju/'hoasi and Khoekhoe. Under this alternative analysis, the only difference between !Xóõ and these other languages (Ju/'hoasi and Khoekhoe) is that !Xóõ has a phonetic edge effect, and the other languages have not thus far been reported to have any such effect[1]. It is not clear what exactly this edge effect is. It may turn out that this edge effect is pragmatically, syntactically or prosodically defined, but much further research will be necessary to determine the nature of this edge effect. One piece of evidence that we do have is that all of the monomoraic words of the CV type above are grammatical morphs. In fact all of the CV type words in the entire !Xóõ dictionary (Traill, 1994) are grammatical morphs, as seen in (7) below:

(7) The Entirety of Monomoraic morphs in !Xóõ

té	'adverbial morph'	tê	'plural suffix'	tû	'plural form.'
kâ	'diminutive prefix'	sà	'diminutive form.'	sà	'verbal form.'
sè	'noun suffix'	sí	'noun suffix'	sí	'transitive part.'
ǀê	'variant of pl.tê'	sî	'sentence connector'	ń	'indicative form.'
ǹ	'noun class 5 pro'	ǹ	'class 5 pronoun, it'	nê	'complementizer'
tê	'plural suffix'	kū	'indeed'	nî	'plural form.'
n̄	'1st pers. sg. pro cl. 1'	à	'past tense form.'	áh	'class 2 pron'
èh	'3rd person sg.cl. 3 pro.'	î	'consecutive'	ūh	'2nd pers. plural'
ùh	'3rd person plural'	ʔàhn	'conjunction'	ʔáh	'gosh'
ée	'yes'	ē	'can, could'		

Traill (personal communication) has confirmed that these words are likely to occur at right edges of phrases, so I will suggest that it is quite likely that the falling pitch found on these words is due to a boundary tone of some kind. Alternatively, it is possible that these words have shortened and were historically bimoraic, as Haacke (1992) has suggested for Khoekhoe. Grammatical words are more likely to be shortened or contracted in languages, since they tend not to occur in positions of prominence. I will show in the last section of this paper that, assuming a boundary tone at the right edge of a phrase, the same constraints necessary for Ju/'hoasi can also account for the !Xóõ facts.

The question of the function of the boundary tone in this language is then an empirical question, which I will pursue in my future research. The hypothesis that !Xóõ has only level lexical tones, as well as phrasal tones, gives an equally strong explanation for why monomoraic words occur with contour tones. Under this hypothesis, monomoraic words all carry level lexical tones which associate to their singleton moras, and the lower tone which makes the contour unit, derives from aspects of the phrasal tonology. This hypothesis allows a stronger similarity between the tonal system of !Xóõ and the other Khoisan languages. Additionally, it allows for a much simpler tonal system in this language, where there are four separate level tonemes. Traill's hypothesis assumes that there are three contour tones, and one level tone, which is a very unusual tonal inventory from a cross-linguistic perspective. Most languages which have contour tones tend to also have level tones. For these reasons, I claim that the alternative hypothesis, that !Xóõ has four level tones, and some kind of phrasal tone occurring at the right edge of words is much more appealing, and I will assume this analysis throughout this paper.

4. Other Evidence for a Decompositional Approach to Ju/'hoasi Tonology

Ju/'hoasi has other evidence, in addition to the fact that monomoraic words only carry level tones, which points more strongly to the necessity of a decompositional approach to contour tones. There is one type of onomatopoeic pattern in Ju/'hoasi where the copied portion of the base word consists only of a single mora. In these forms, the first mora of the base is copied along with the initial consonant, and only level tones are copied, even in forms where the base word has a contour tone.

Assuming that tones are copied along with the segmental material in onomatopoeia, the contour unit hypothesis predicts that the entire tonal pattern of the base word should be copied along with the first mora. The hypothesis that tones are separate level tones which combine to form contours under certain circumstances, predicts that only one tone will be copied, since only one tone will associate to the copied mora. Onomatopoeic words which conform to this pattern are given in (8):

(8) Onomatopoeic Pattern in Ju/’hoasi (underlined morph is copied)

txà	txàbé	'to be irritated (of one's eyes)'
bȁ	bȁrȉ	'to jump up and run quickly away'
g‡úN	g‡úNcè	'small brown species of ant'
gò	gòró	'heel'

(N = Nasalization of preceding vowel)

It is clear that tones are copied in these forms, since it is otherwise totally unpredictable which toneme would surface on the copied portion. In all of these forms, only the first tone is copied. This bears out the predictions of the decompositional approach. This is further evidence that Ju/’hoasi tones are single level tone units which can combine to form contours, and not phonological contour tone units.

5. The Systematic Nature of Tonal Patterns

The largest hurdle for a decompositional analysis of Khoisan tone patterns into sequences of level tones is the fact that attested tone patterns are restricted. With a four level tone system, sixteen possible tone patterns are predicted. The predicted patterns are given in (9), along with an indication of which patterns are attested in Ju/'hoasi and !Xóõ. Ju/'hoasi only has seven of the sixteen patterns, while !Xóõ only has four. However, all of the tone sequences in these languages follow a pattern. In Ju/'hoasi, all four level tones are attested, two rising tones, as well as one falling tone. In !Xóõ, only identical tones are attested.

(9) Predicted and Attested Tonal Sequences

Predicted		Ju/'hoasi	!Xóõ
SH	SH	Yes	Yes
High	High	Yes	Yes
Low	Low	Yes	Yes
SL	SL	Yes	Yes
Low	High	Yes	No
SL	Low	Yes	No
High	Low	Yes	No
SH	High	No	No
High	SH	No	No
Low	SH	No	No
SL	SH	No	No
SH	SL	No	No
SH	Low	No	No
Low	SL	No	No
High	SL	No	No
SL	High	No	No

It is important to note that only sequences of tones which are one step apart on the tonal scale are attested in both languages. This is surely not an accident. Additionally, the tones in Ju/'hoasi are for the most part rising tones, and the tones in !Xóõ are level. The analysis of the optimality of the tonal patterns which are attested in each language will be undertaken in section (8). The next section will show evidence for toneless moras, which are completely predictable tonally.

6. Evidence for Scalar Use of Pitch in Ju/'hoasi

The fact that all tone sequences in Khoisan languages are adjacent on the tonal scale indicates the need for a scalar feature to capture the tone patterns in these languages. There is further evidence which shows that this must be the case in Ju/'hoasi. There are two types of words in the language which have underlyingly toneless moras. The second tone on these words is completely predictable, and is always one step away on the tonal scale. These cases involve words with so-called interrupted vowels (see Snyman, 1977 for an account which justifies this name), which I analyze as vowel-glottal stop-vowel sequences, and interrupted nasals which are glottal stop-syllabic nasal sequences.

Dickens(1994) claims that the tone of syllabic nasals is completely predictable, and "is always pronounced with the next higher tone." This is shown in (10):

(10) Predictability of Second Tones in Words with Syllabic Nasals

ŋǀàʔŋ̩́	'delicious'	ŋǂàʔŋ̩́	'toe'
gàʔḿ̩	'to hide'	ǁàʔḿ̩	'indeed'
nàʔḿ̩	'black korhaan'	gȍʔm̩̀	' to tan skins'

The second mora of an interrupted vowel is also completely predictable, being one step higher on the tonal scale. This fact is shown in (11):

(11) Predictability of Second Tone in Words with Interrupted Vowels

áʔàN	'no'	càʔáN	'to be this high'
dàʔáN	'fire'	ȁiʔí	'to be in a hurry'
gǂȁʔò	'species of wasp'	ȷȁqʔò	'clean'

(q= pharyngealization (narrowing) of preceding vowel)

The predictability of the toneme in the second moras is indicative of these moras being underlyingly toneless. However, there are other ways of interpreting these facts. There are, fortunately, words which make the case stronger. There are some interrupted vowels in trisyllabic words which are monomorphemic. These are the only words in the language which are trisyllabic and monomorphemic, since morphemes are maximally bimoraic and bisyllabic in Ju/'hoasi. A few of these words are given in (12) below:

(12) The only Trisyllabic & Monomorphemic words in Ju/'hoasi

dùʔúŕí	'slough'	gǂòʔóré	'buffy piffit'
g!ùʔúní	'to tighten'	g!ùʔúŕí	'plant species'
g‖àʔámá	'today, now'	kàʔábé	'to fold over'
zàʔól'ó	'bitter appleleaf'	!ùʔúrú	'finger/toe nail'
‖àqʔáŕí	'grass species'	tàʔábí	'peep under s.t.'

Thus, these are the only monomorphemic words in Ju/'hoasi which disobey the strong constraint on the maximal word. If these words are underlyingly trimoraic and trisyllabic, it would be a very big coincidence that all of the monomorphemic words which are trisyllabic contain interrupted phones. If however, these words are underlyingly bimoraic and bisyllabic, then this fact is explained, as well as the predictability of the derived mora's tone height. Thus, I claim that these words are underlyingly bimoraic, and give an optimality theoretic account of their trimoraic forms in section (7) below.

7. The Optimality of Interrupted Sounds in Ju/'hoasi

If the third mora in the trimoraic monomorphemic words above is not present underlying as I have suggested, what causes it to be moraic on the surface? The high ranking constraint is a constraint against glottal stop codas. This is then a type of epenthesis which is syllable structure driven. The difference here is that no features are inserted, but rather features are spread from the previous mora. All that is inserted is the bare mora. This constraint crucially outranks the constraint on the maximal word.

The only coda found in Ju/'hoasi syllables is [m]. Thus, I formulate the relevant syllable structure constraint as in (13)(a), the constraint ruling out epenthetic moras as in (13)(b), and the constraint ruling out morphs larger than two moras as in 13(c):

(13) (a) CODA-m [3]: Only [m] can be a coda consonant.

(b) DEP MORA: Every mora in S2 must have a correspondent in S1.

(c) WORD = Σ: A word is maximally a foot.

The constraint barring glottal stop codas crucially outranks the constraint barring epenthetic moras as shown in the tableau in (14):

(14) CODA-m >> DEP μ in Ju/'hoasi

/ g!àʔm /	CODA-m	DEP μ
g!aʔm	*!	
☞ g!a .ʔm̥		*

Additionally, CODA-m is more highly ranked than word maximality, as show in (15):

(15) CODA-m >> WORD = Σ in Ju/’hoasi

/ joʔma /	CODA-m	WORD = Σ
joʔ.ma	*!	
☞ jo.ʔo.ma		*

Thus, I have shown that the so-called interrupted vowels in Ju/’hoasi are optimal because they insert the minimal amount of material which avoids illegal coda consonants. This account explains why the only trisyllabic monomorphemic words in Ju/’hoasi all have interrupted segments in them, and why the tonality of these segments is entirely predictable from the tone of the preceding mora. If these moras are underlyingly present, this would be a very remarkable coincidence, and that’s all. I conclude that these moras are only present on the surface, and the surface tone is governed by a set of ranked constraints. Before proceeding to the Correspondence Theory (McCarthy and Prince, 1995) account of the tonology in section (9), I will first discuss the tonal features which are necessary to account for the data.

8. A Scalar Feature for Tone

First of all, I showed in section (4) above, the tonal patterns which are attested in both Ju/'hoasi and !Xóõ. All three tone contours found in Ju/’hoasi are sequences of tones which will be adjacent on the pitch scale. In this section I will show that traditional tonal features are not capable of capturing this generalization. I will then propose a scalar tone feature which allows an elegant statement of this generalization.

Tsay (1994) proposes a feature based on the phonetic analog of pitch, fundamental frequency (f_o) which is scalar in order to account for languages which have more than one rising or falling tone. The feature is scalar, and can have as many values as there are tone levels in a given language. A four tone system which seems to be standard in all Khoisan languages would then be indicated by the features [1p]-[4p] which represent the four different tone heights as shown below in (16):

(16) Scalar Use of Pitch

<---SL------L-------H-----SH---->

Tsay (1994): [1p] [2p] [3p] [4p]

Yip's (1993) register features will not work for these cases. Yip uses two features to handle tone. One is register, which is divided into the lower and upper registers, and the other feature is [+/- high], which divides each register into [High] and [Low] tones. Under Yip's analysis, the four tone levels found in Ju/'hoasi and !Xóõ would be characterized as in (17) below:

(17) Register Features (Yip, 1993)

Register			
Lower Register		Upper Register	
Low	High	Low	High
(Super Low)	(Low)	(High)	(Super High)

These features cannot give a unified characterization of the three contour tones found in Ju/'hoasi. I characterize the relationship of the contour tones in Ju/'hoasi as feature filling rules in (18) since as I argued in section (5), in at least some cases, the contour tones arise in cases where one of the moras is underlyingly toneless. These rules are similar to Snyman's (1975) two rules of tone raising and tone lowering, although Snyman does not make the environment for his rules explicit. In the first rule, a low tone is inserted following a SL tone, and the two tones will differ by one feature specification. In the second and third rules the adjacent tones will differ by two features. This misses the generalization that all of the tone sequences are adjacent on the tonal scale. The characterization as rules is used to make the problem clear, but I do not claim that rules are part of the phonology. Constraints which govern surface tonal patterns will be posited in section (9).

(18) Feature Filling Rules which Represent the Tonal Relationship Found in Ju/'hoasi Contour Tones

Ø => Low /		SL	___	
[high]		[low]		(Dissimilation of
[-upper]		[-upper]		one feature)

Ø=> High	/	Low	___	
[low]		[high]		(Dissimilation of
[+upper]		[-upper]		two features)

Ø=> Low	/	High	___	
[high]		[low]		(Dissimilation of
[-upper]		[+upper]		two features)

I thus propose a scalar feature for tone, which is shown in (19). This feature is similar to Tsay's in that it is scalar, but it differs in that each tone level is characterized literally by an addition of a new [pitch] feature. This new feature is similar to Parkinson's (1996) feature [closed], which accounts for the stepwise patterns found in vowel harmony systems. Each [pitch] feature constitutes a particle of tone. When the particles are stacked up on each other, they become higher tones. This feature allows a unified characterization of the stepwise pattern found in Khoisan tonology.

(19) Privative Phonetically Based Feature for Tone

	SL	L	H	SH
[Pitch]	•	•	•	•
[Pitch]		•	•	•
[Pitch]			•	•
[Pitch]				•

Khoisan tonal systems are stepwise, and thus predictable tonal patterns are sequences of tones which differ only by one specification of the feature [pitch]. This generalization can only be handled by a scalar theory of pitch such as I have proposed.

9. Optimality Theoretic Analysis of Ju/'hoasi and !Xóõ Lexical Tone Systems

In this section, I give an optimality theoretic analysis of Ju/'hoasi lexical tone which uses a unified constraint set. There are several assumptions which are implicit in my analysis. First of all, I assume that contour tones in Ju/'hoasi arise from underlying forms with only one mora that has a pitch specification, as was shown to be the case for interrupted vowels and interrupted nasals. Secondly, I assume that moraic structure is underlyingly present, which I justify by the fact that vowel length is contrastive. Given these assumptions, the analysis is quite straightforward. I will then show that an analysis of !Xóõ tonology can be given using the same constraint set.

The fact that vowel length is contrastive in both languages is shown in (20) below:

(20) (a) Vowel Length Contrast in Ju/'hoasi

tshȉ	‘to laugh’	tshȉȉ	‘terrapin’
bò	'to stoke a fire'	bòó	'axe'

(b) Vowel Length Contrast in !Xóõ

kū	'indeed'	kūu	'sheep'
kâ	'passive formative'	káa	'metal box, trunk'

The constraints needed to handle the analysis of both Ju/'hoasi and !Xóõ lexical tone are given in (21). The phonotactic constraint (*T SH), which mediates against sequences containing SH tones is only active in Ju/'hoasi.

(21) Constraints Governing Khoisan Lexical Tone

*TONELESS:	Every Mora must have a [PITCH] feature associated to it.
MORA =TBU:	Every Toneme in S1 must correspond to only one mora in S2.
DEP [PITCH]:	Every [PITCH] feature in S2 must have a corresponding [PITCH] feature in S1.
*FALL:	Tonal sequences should not fall in pitch.

TONAL SIMILARITY:
Adjacent moras must not differ in more than one [pitch] specification

*T SH: SH cannot combine with other tones[2].

OCP: Adjacent tones within a morpheme should not be identical.

The first tableau in (22) shows that both *TONELESS and MORA=TBU must dominate DEP[PITCH] in Ju/'hoasi. The underlyingly toneless nasal consonant cannot surface without a tonal specification like the (a) candidate , as it will be ruled out by *TONELESS. MORA=TBU rules out the (b) candidate, which tries to specify both moras with the same underlying tone, giving an illicit doubly linked structure. DEP[PITCH] is violated by the predicted surface candidate which adds one [pitch] specification, giving for this word, a L SL sequence, which is not the optimal form. The nonoptimal status of the chosen candidate is marked here by the symbol ❽ :

(22) *TONELESS, MORA=TBU >> DEP [PITCH] in Ju/'hoasi

g!àʔm	*TONELESS	MORA=TBU	DEP [PITCH]
[pitch] [pitch] a.g!à.ʔm̥	*!		
[pitch] [pitch] b. g!à.ʔm̥̀		*!	
[pitch] [pitch] [pitch] c.❽ g!à.ʔm̏			*

The correct surface tone is L H. However, this form cannot be optimal given any ranking of the three constraints shown here, because it can never be optimal to incur more DEP[pitch] violations. Thus, I propose two additional constraints, *FALL and the OCP. If *FALL outranks DEP[PITCH], this will force the insertion of two instances of [pitch]. However, the OCP is still necessary to rule out a sequence of level tones, and force the insertion of the third [pitch] feature, resulting in the optimal candidate having a rising tone. The OCP must be ranked lower than DEP[PITCH] in order to account for surface level tone words which will be shown later. However, it is important to note that once DEP[PITCH] is violated, it doesn't matter how many violations it gets. It is better to satisfy the lower ranked OCP constraint, than to incur less violations of DEP[PITCH]. This follows my intuition that even though [pitch] features are separate, they act as one surface toneme.

(23) *FALL>> DEP[PITCH] >> OCP in Ju/'hoasi

g!àʔm	*FALL	DEP[PITCH]	OCP
[pitch] **[pitch]** **[pitch]** [pitch] [pitch] a.☞ g!à.ʔḿ̥		*	
[pitch] **[pitch]** [pitch] [pitch] b. g!à.ʔm̥̀		*	*!
[pitch] [pitch] [pitch] c. g!à.ʔm̏	*!	*	

I showed above that there are some forms which have H L tone sequences, or falling sequences. The tableau representing these types of contours is shown in (24). I claim that these tone sequences are optimal due to the highly ranked *T SH, which mediates against contours containing SH tones. Another constraint TONAL SIMILARITY is necessary in order to capture the generalization that all tones in the language are adjacent on the tonal scale. These both crucially outrank *FALL, since the optimal candidate (b) surfaces with a falling tone.

(24) Ju/’hoasi: *T SH, TONAL SIMILARITY >> *FALL

gǂó’oàn	*T SH	T-SIMILARITY	*FALL
[pitch] [pitch] [pitch] | **[pitch] [pitch] [pitch] [pitch]** / a. gǂó’ő̋àn	*!	*(2nd & 3rd moras)	*(2nd & 3rd moras)
[pitch] [pitch] [pitch] \ **[pitch] [pitch]** | b. ☞ gǂó’òàn			*(*)
[pitch] [pitch] [pitch] | **[pitch]** / c. gǂó’ȍàn		*!	*

Since the second mora of these words is underlyingly toneless, DEP[PITCH] is necessarily violated - forced by high ranking *TONELESS. The reader will recall from section (8) above the justification for using a scalar feature. Yip’s register feature will not allow a characterization of H and L tones as being similar. In fact, the characterization of H and L tones in her theory cause H and L to be treated as entirely dissimilar. Thus, a constraint requiring TONAL SIMILARITY would never predict the HL falling pattern or the LH rising pattern in Ju/’hoasi to be optimal.

In (25) below, I show the analysis of level tone words. Since there are already [pitch] features in the underlying form, there is no reason to add more. *TONELESS is already satisfied. Thus, it is better to satisfy DEP[PITCH] at the expense of lower ranked OCP, and the underlying tonal specification surfaces as a level tone. *FALL is satisfied by both candidates.

(25) *FALL >> DEP[PITCH]>>OCP in Ju/'hoasi Level Tone Words

ŋǂòè	*FALL	DEP[PITCH]	OCP
[pitch] [pitch] [pitch] [pitch] [pitch] a. ŋǂòé		*!	
[pitch] [pitch] [pitch] [pitch] b. ☞ ŋǂòè			*

The total constraint ranking for Ju/'hoasi is as in (26).

(26) Total Constraint Ranking Proposed for Ju/'hoasi

CODA-m >> DEP μ , WORD = Σ
*T SH, Tonal Similarity >>*FALL>> *TONELESS,
MORA=TBU>>DEP[PITCH]>>OCP

CODA-m outranks DEP μ and WORD = foot. This ranking was established with evidence from the interrupted vowels and nasals. The tonal constraints *TONELESS and MORA=TBU outrank DEP[PITCH

*T SH and TONAL SIMILARITY, which all outrank *FALL. *FALL only comes into play in words which have underlyingly toneless moras. In the cases I have shown they are toneless because they are not underlyingly moraic. Thus, under my analysis, it is predicted that all contour tone words must have underlyingly toneless second moras, or derived moras. This is an empirical claim which is testable. However, evidence will not come easily as Khoisan languages are generally nonalternating.

10. The Domain of Tonal Restrictions

One more crucial fact about Ju/'hoasi tone is that all of the constraints used in my analysis of the tonal system only hold within the domain of the morpheme. This is consistent with Elderkin's (1989) claim that "the optimal unit to use in stating how sound is organized in these two languages [Ju/'hoasi and !Xóõ] is the morph. If words contain more than one morpheme, then the possible tonal sequences are completely unconstrained. In (27) I show cases where the diminutive morpheme [ma] occurs with different base nouns. Note that in all of the forms given here the [ma] morpheme has [low] tone. This is completely independent and unpredictable from the tone of the previous morph, the base noun. Thus, [ma] must be underlyingly specified as low toned.

(27) Diminutive Forms Containing Low Toned Suffix

ǁʔòmmà	‘little girl’	ɗȁʔàmàmà	‘grandchild’
dshàúmà	‘girl’	txúnmà	‘granddaughter’
ǀȍ̤ȅ̤mà	‘foal’	!ű́mà	‘namesake’
n!^{h}ȁimà	‘lion cub’	ǀ^{h} ȁinmà	‘springhare bag’
ǂ ȍqè!òmà	‘son’	gùúmà	‘lamb’
txúng!ámà	‘brother in law’	tsúmà	‘younger uncle’
gű̄mímà	‘calf’	gǂűínmà	‘puppy’
g!ááímà	‘tadpole’	!^{h}ámà	‘animal’

Two other morphemes [di] , indicating femininity, and [si] indicating 'place,' both surface with [high] tone regardless of the tone of the root noun, as shown in (28):

(28) Forms Containing High Toned Suffixes

gúmíɗí	‘cow	tcxááíɗí	‘female dance’
gùúɗí	‘ewe’	ǁʔááíhàɗí	‘rich woman'
ǁàòɗí	‘afterbirth’	ǀȍ̤ȅ̤ɗí	‘mare’
ǀáríɗí	‘female jackal’	ǀʔ^{h}óánɗí	‘sow’
ǁàòɗí	‘afterbirth’	ǂʔ ȁnɗí	‘left arm, left side’
ŋ!^{h}ȁiɗí	‘lioness’		

ǁkòàsí	‘workplace’	ŋǀȁḿ̹sí	‘dancing place’
ŋǂȍ̤ȁnsí	‘meet place’	ži̋sí	‘toilet’
ǀȁqȍnsí	‘promiscuity’	gȕnȉsí	‘hunting place’
!ʔàùsí	‘calling, shouting’	kòàràsí	‘place of death’
ŋǀááímànȉsí	‘giddiness’	ŋ!àòsí	‘loading place’

Additionally, in all of the compound words in Dickens (1994) there is no change from the tonal forms of the individual roots. Some exemplary forms are shown in (29):

(29) Tone in Compound Words

Compound Noun	Gloss	1st Noun	Gloss	2nd Noun	Gloss
àȉtsȋ	'flock of guinea fowl'	àȉ	'guinea fowl'	tsȋ	'flock'
bȁrạ̤tsíá̋	'thing of wet season'	bȁrạ̤	'wet season'	tsȋ	'thing'
sá|ámà	'holiday'	sá	'rest'	|ámà	'day'

It thus appears that compounds also act as two separate morphs. However, Elderkin (1989) shows that from Snyman's (1975) data there are some differences in tone between compounds and their composite roots. Thus, compounds are perhaps in need of future investigation. For the present, the data suggest that the domain of all of the above tonal restrictions is the morpheme.

11. Application of the Analysis to !Xóõ

I have shown in the previous sections that the !Xóõ lexical tone system is parallel to the Ju/'hoasi systems in many respects. There are four level tones, but the attested combinations of these tones within a morpheme are only a quarter of what is predicted to be found. There is one main difference between !Xóõ and Ju/'hoasi, which I will discuss in this section, and that is accepting the assumption that the low tone which always occurs at the right edge is not part of the lexical tonology, there are no contour tones in the language at all. In this section, I will suggest an analysis using the same constraints above which will predict this system. The main difference is that all !Xóõ words are fully specified for tone level underlyingly.

The constraint system for !Xóõ seems to be exactly like the constraint system found in Ju/'hoasi, with two changes. First of all, there is no constraint restricting SH tones from co-occurring with other tonemes. Additionally, all words are underlying specified for tone, and thus there is no evidence for rankings among the constraints. The OCP must be lower ranked than DEP[PITCH] in order to guarantee that there will never be contour tones in the language. Given these assumptions, all words surface with level tones given the same constraints. This is shown in tableau (30):

(30) *FALL , DEP[PITCH] >> OCP in !Xóõ

dt^{h}àba	*FALL	DEP[PITCH]	OCP
[pitch] **[pitch]** **[pitch]** [pitch] [pitch] a. dt^{h}àbá		*!	
[pitch] [pitch] [pitch] [pitch] b.☞ dt^{h}àbà			*

12. Conclusion

I have presented evidence for a decompositional approach to Ju/'hoasi and !Xóõ lexical tonology. Ju/'hoasi does not allow contour tones on monomoraic words, and onomatopoeic patterns which copy one mora of a morph, only copy level tones. The situation in !Xóõ is more complex. I have claimed that all words in !Xóõ are level toned underlyingly, and that the pitch fall at the right edges of words is a part of the phrasal tonology, which is suggested by the fact that the only monomoraic words which carry contour tones are grammatical morphs which always occur at the right edges of phrases. Alternatively, these words might be underlyingly bimoraic, but shorten phonetically since they are grammatical words, and tend to occur in nonprominent positions. Both languages have severe restrictions on the tonal sequences which are allowed to surface within the morpheme. Both have all possible level tones. In addition, Ju/'hoasi has three rising tones and one falling tone, while !Xóõ has no lexical contour tones. The tonal systems are analyzed as having the same constraint ranking, and the difference lies in Ju/'hoasi having some underlyingly toneless moras, while all moras are tonally specified in !Xóõ. All possible contours in Ju/'hoasi contain tones which are adjacent on the tonal scale. This fact inspired the use of a phonetically based scalar feature for tone.

NOTES

[1] Haacke(1992) has shown that Khoekhoe has phrasal sandhi.

[2] Possibly [m] is the only coda because it is a remnant of a concordial suffix (Sands,1997)

[3]SH tone does not even combine with tokens of itself. No bimoraic words contain SH.

REFERENCES

Dickens, Patrick

1994 *English-Ju/'hoan-Ju/'hoan-English Dictionary*.Quellen zur Khoisan Forschung 8. Köln: Rüdiger KöppeVerlag.

Elderkin, Edward

1989 *The Significance and Origin of the Use of Pitch in Sandawe* . University of York Dissertation in Linguistics.

Haacke, Wilfred

1992 *The Tonology of Khoekhoe*. Ph.D. University of London Dissertation in Linguistics.

McCarthy, John and Alan Prince

1995 Faithfulness and Reduplicative Identity.Rutgers University and the University of Colorado, MS.

Parkinson, Frederick

1996 *The Representation of Vowel Height in Phonology*. Ohio State University Ph.D. Dissertation in Linguistics.

Prince, Alan and Paul Smolensky

1993 Optimality Theory: Constraint Interaction in Generative Grammar *Rutgers University Center for Cognitive Science Technical Report 2.* New Brunswick, N.J.

Sands, Bonny E

1997 *Eastern and Southern African Khoisan: Evaluating Claims of Distant Linguistic Relationships*.Köln: Rüdiger Köppe Verlag.

Snyman, J. W.

1977 The Interrupted Juxtaposed Vowels of Zu/'hõasi. in Anthony Traill, Ed. *Khoisan Linguistic Studies 3*. A.S. I. Communication #6.

Snyman, J. W.

1975 *Zu/'hõasi Fonologie & Woordeboek* . Cape Town: A. A. Balkema.

Snyman, J. W.
1970 *An Introduction to the !Xũ Language*. Cape Town: A. A. Balkema (and accompanying cassette tapes)

Traill, Anthony
1994 *A !Xóõ Dictionary*. Quellen zur Khoisan Forschung 9.Köln: Rüdiger Köppe Verlag.

Traill, Anthony
1985 *Phonetic and Phonological Studies of !Xóõ Bushman*. Quellen zur Khoisan Forschung I.Hamburg: Helmut Buske Verlag.

Tsay, Suhchuan Jane
1994 *Phonological Pitch*. University of Arizona Ph.D. Dissertation in Linguistics.

Yip, Moira
1993 Tonal Register in East Asian Languages. *The Phonology of Tone: The Representation of Tonal Register*, ed. by Harry Van der Hulst and Keith Snider, 476-494.New York: Mouton de Gruyter.

I gratefully acknowledge the helpful comments and suggestions of David Odden. I would also like to thank Henry Honken and Bonny Sands for useful discussion regarding Khoisan phonological systems.