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#### Citation for published version:

Bradfield, J 2018, 'Clicks, elements and concurrency' Toronto Working Papers in Linguistics, vol 40.

#### Link:

[Link to publication record in Edinburgh Research Explorer](#)

#### Document Version:

Peer reviewed version

#### Published In:

Toronto Working Papers in Linguistics

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# Clicks, elements and concurrency\*

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Khoisan languages have always posed a challenge to formal phonology in the generative tradition, as their very large apparent inventories require an array of features used nowhere else. I recently (2014) proposed a solution to this in terms of ‘concurrent phonemes’. In this article, I look at Khoisan from the point of view of non-linear phonology, and investigate the application of the concurrent phoneme in this framework.

## 1 Introduction

Khoisan languages are well known for their large consonant inventories, with the Taa (!Xóǀ) dialect cluster running to 87 consonants in the analysis of Naumann (2016), together with 77 initial consonant clusters, not to mention 26 vowels.

These inventories have always been a little challenging for formal phonology in the generative tradition, as they seem to require the invention of large numbers of features which appear nowhere else in the world. Chomsky and Halle (1968) included several features in *The Sound Pattern of English (SPE)* simply to deal with the fairly modest inventories of Zulu and Khoekhoe (Nama); the few semi-formal accounts of Taa use either many more features, or complex feature geometries (Güldemann, 2001/2016; Traill, 1993).

In Bradfield, 2014, I propose a different approach, in which the complexity is dealt with not by adding features, but by redefining the phoneme and phonotactics to allow parallel or ‘concurrent’ clustering, in a way similar to, but more constrained than, autosegmental phonology. I argued that the proposal has several benefits, including reducing the Taa inventory size to an entirely normal level, and giving good accounts of various Taa and general Khoisan phonological phenomena. I presented my suggestion in the framework of *SPE*, but claimed it is applicable to other frameworks, including autosegmental frameworks.

One such framework is Element Theory and Government Phonology (GP) (the two are not the same, but in practice GP is mostly done with elements, and elements are mostly used for GP). Although rather eclipsed in recent years by Optimality Theory done in a Jakobsonian framework, Government Phonology remains an active area. Much of the appeal of GP is its drive for simplicity and parsimony, together with the intuitively appealing idea (at least in its original versions) of elements that have in themselves a concrete realization, rather than abstract features—for example, the element **A** is described (Harris, 1994) as ‘mass’: acoustic energy concentrated in the centre of the spectrum.

However, GP has been conducted almost entirely on languages that are relatively simple in terms of phonological inventory; English, Danish and Arabic (Bellem, 2007) are the most complex languages for which I know of a GP account. This article conducts a preliminary exploration of Khoisan, and in particular Taa, from an element theory and GP perspective. I first consider the representation of the ‘exotic’ sounds via elements, and then discuss whether the ‘concurrent phoneme’ concept brings advantages, and finally sketch some issues of Taa phonology in the framework.

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\*I thank Krisztina Polgárdi for discussions on the topic of this paper.

## 2 Background

I assume the reader is familiar with the basics of click language phonetics. A recent survey is Miller, 2011, and Bradfield, 2014 also contains a summary for the general phonologist. In brief, a click sound in linguistic use comprises (a) the click proper, formed by the implosion of air into a vacuum between the *posterior closure* of the back of the tongue against the soft palate, and the *anterior closure* formed by the lips or tongue front; (b) the *accompaniment*, which adds modifications such as aspiration, nasality, etc. to the (post)velar stop formed by the release of the posterior closure.

### 2.1 Taa and its sounds

Taa, often called !Xóǒ, is a Khoisan language of the Tuu family, spoken by a few thousand people in Namibia and Botswana. There are several dialects; East !Xóǒ was the focus of Tony Traill’s research (see particularly Traill, 1985, 1994) from the 1970s until his untimely death in 2007. West !Xóǒ (or West !Xoon in the current orthography) was the focus of a DoBES<sup>1</sup> documentation project, the main researcher being Christfried Naumann.

Taa has a very simple word structure. Phonologically, a content word (noun, verb, adjective) has two moras. The first has a consonant cluster (usually including a click) followed by a vowel (which carries tone and may have several voice qualities); then the second mora has an optional initial consonant (from a very small set), and a vowel or nasal (which carry tone). For example, /!ólò/ ‘to be late’; /<sup>9</sup>!q<sup>h</sup>ùm/ ‘flower’ (where the /m/ is moraic). Function words are typically but not invariably monomoraic (e.g., /#a/ ‘and’; /ká/ modal particle); and loan words and onomatopoeic words may vary from this structure. These words may then be extended with (usually monomoraic) affixes to form longer phonological words; such affixes do not contain clicks. Compound words are also possible, and (at least in the dialect studied by Traill) reduplication of the entire word is a common phenomenon.

In this article I shall not discuss tone.

Taa has clicks at five places of articulation: labial /ǀ/, dental (affricated) /ǃ/ (Zulu *c*), lateral alveolar (affricated) /ǁ/ (Zulu *x*), alveolar /ǂ/ (Zulu *q*), and palatal /ǁ̟/. The range of accompaniments is extensive: a click can be modified with voice (often appearing as heavy pre-voicing), aspiration, ejection, nasalization, or pre-glottalized nasalization. Voicing combines freely with the other modifications.

The non-click consonant inventory is also extensive, with a similar pattern.

Moreover, the word-initial consonant clusters allow voiced and voiceless clicks to combine with a following uvular or glottal consonant, to produce initials such as /<sup>9</sup>!q/. In earlier work, these were considered separate phonemes, but it is now generally (though not completely—see Miller et al., 2009 for a dissenting view) agreed that they are consonant clusters.

The vowels are based on a standard five-vowel system, but can be modified by nasality, breathiness, creakiness, pharyngealization or stridency. (Stridency is phonetically epiglottalization; Traill (1985) proposed that stridency is phonologically a combination of breathiness and pharyngealization.)

The result, using phonetically transparent notations for the accompaniments, is the inventory of single phonemes displayed in Table 1, following the analysis of Naumann (2016).

The word-initial consonant clusters are: plain or voiced clicks (marked † in the table) followed by a glottal or voiceless uvular consonant (marked ‡ in the table) (e.g., /!q<sup>h</sup>, <sup>9</sup>+q’, ǀh/); and plain dental stops and affricates (marked § in the table) followed by /χ/ or /qχ’/ (e.g., /tsχ/).

<sup>1</sup>Volkswagen Foundation programme *Dokumentation Bedrohter Sprachen* (Documentation of Endangered Languages), <http://www.mpi.nl/DOBES/>

Table 1: Phoneme inventory of Taa

p	t §	ts §	ʘ †	l †	! †	ɬ †	†	k	q †	ʔ †	i	e	a	o	u
b	d §	dz §	ᵑʘ †	ᵑl †	ᵑ! †	ᵑɬ †	ᵑ   †	g	ɕ		ĩ	ẽ	ã	õ	ũ
p <sup>h</sup>	t <sup>h</sup>	ts <sup>h</sup>	ʘ <sup>h</sup>	l <sup>h</sup>	! <sup>h</sup>	ɬ <sup>h</sup>	<sup>h</sup>	k <sup>h</sup>	q <sup>h†</sup>		ĩ	ẽ	ã	õ	ũ
b <sup>h</sup>	d <sup>h</sup>	dz <sup>h</sup>	ᵑʘ <sup>h</sup>	ᵑl <sup>h</sup>	ᵑ! <sup>h</sup>	ᵑɬ <sup>h</sup>	ᵑ   <sup>h</sup>	g <sup>h</sup>	ɕ <sup>h</sup>		ĩ	ẽ	ã	õ	ũ
p'	t'	ts'	ʘ'	l'	!'	ɬ'	'	k'	q', <sup>†</sup> q <sup>ɰ†</sup>				a <sup>ɕ</sup>	o <sup>ɕ</sup>	u <sup>ɕ</sup>
		dz'	ᵑʘ'	ᵑl'	ᵑ!'	ᵑɬ'	ᵑ  '	g <sup>ɕ</sup>	ɕ <sup>ɰ'</sup>				a <sup>ɕ</sup>	o <sup>ɕ</sup>	u <sup>ɕ</sup>
m	n	ɲ	ᵑʘ	ᵑl	ᵑ!	ᵑɬ	ᵑ	ŋ							
			ᵑʘ	ᵑl	ᵑ!	ᵑɬ	ᵑ								
ʔ <sub>m</sub>	ʔ <sub>n</sub>		ʔᵑʘ	ʔᵑl	ʔᵑ!	ʔᵑɬ	ʔᵑ								
f	s								χ †	h †					
w	l	j													
	r														

## 2.2 Concurrent clicks

The thesis of Bradfield, 2014 is that the notions of ‘segment’ and ‘phoneme’ should be redefined, so that they can combine ‘in parallel’ as well as sequentially. Thus, I argued, Taa does not have the 45 click phonemes that appear in the table above. Instead, it has five ‘pure click’ phonemes /ʘ, l, !, ɬ, /, which combine ‘concurrently’ with nine ‘accompaniment phonemes’ /ɰ, ᵑɰ, ɰ<sup>h</sup>, .../. The thesis is supported by arguments from learnability, speaker perception and production, and from the phonology of Taa.

The learnability argument is based on the small proportion of phoneme contrasts that are supported by minimal or near-minimal pairs. If the learner has to establish almost a thousand pairwise contrasts (as is the case with 45 click phonemes), but only has support for around half of them (as appears to be the case), the acquisition challenge is formidable. However, if pure clicks and accompaniments are independent, the number of contrasts is very much smaller—entirely typical, in fact, with 20 pairwise click contrasts and 36 pairwise accompaniment contrasts—and all are well supported. (See Bradfield, 2014 §§3.3, 4.2.4 for more on the combinatorial argument.)

In Bradfield, 2014 I cite previous work (chiefly Best, Traill, Carter, Harrison, & Faber, 2003) to argue that speakers perceive accompaniments independently from the clicks. I also provide (§4.2.2) experimental evidence that production of clicks and accompaniments is learned independently.

The phonological argument rests mainly on the curious interaction of clusters such as /lq/ with the raising of /a/ in certain contexts. The dental click // is a trigger for raising, and it remains so even when ‘followed’ by a distinct uvular stop /q/, which one would normally expect to block any raising effect of a preceding consonant. I explained this by analysing /lq/ as /l(⊗ɰq)/, namely a concurrent cluster of the click with a sequential cluster of an accompaniment and a uvular stop, so that a following vowel ‘sees’ both the click and the accompaniment.

I anticipated (§4.2.3) the obvious criticism of such a proposal that it is not significantly different from autosegmentalism, and gave a number of counter-arguments. I also claimed that my theory can be implemented in a non-linear formalism such as GP, as well as in the *SPE* framework I used there. This latter claim will be tested here.

## 2.3 Government Phonology and Element Theory

Government Phonology (GP) in its ‘standard’ form originated with Kaye, Lowenstamm, and Vernaad (1985, 1990). It arose as part of the non-linear movement of the 1970s and 1980s, and there were a number of related theories, such as Dependency Phonology (Anderson & Ewing, 1987). In the last decade, there has been a continuing development of GP into what is called ‘GP 2.0’ (Kaye, 2000; Pöchtrager & Kaye, 2013); however, this latter development is largely in manuscript, and remains fluid. It is characterized by a strong move to abstraction, and a reduction in the number of elements, compensated for by increased use of structure.

In this article, I shall take as a basis the version of Harris (1994), which has the advantage of accessibility, as well as a fairly generous set of elements compared to later theories. It has also eliminated some of the complexities of the original theories (such as ‘charm’).

In a basic GP representation, there is a set of phonological *primes* or *elements*, whose interpretation has varied somewhat over different theories, and which typically have different but related meanings in vowels and consonants. For example, /e/ typically contains the elements {**A,I**}, where **I** contributes the frontness, and **A** the non-highness. Or, in Harris, 1994, (unaspirated) /t/ is {**R,?,h**} (coronality, occlusion, release); /q/ might be {**A,?,h**} (backness, occlusion, release).

The elements, which are in a sense privative features, are usually taken to inhabit separate *autosegmental tiers*. The coordination between elements is arranged by *associating* them to the *skeletal tier*, which gives the lowest level of prosodic structure. The skeletal tier is typically inhabited by C or V slots indicating consonants or vowels; or in some theories just by X slots. Thus, as in most autosegmental theories, the concepts of segment and phoneme are strictly speaking not primitives, but emerge from the possible associations of elements with a skeletal point.

It was found that simple combination of elements was not sufficient to allow either the natural expression of all sounds, or the formulation of adequate descriptions of phonological processes. Therefore GP theories add structure to the sets of elements that can be associated with a skeletal point. The typical structure, used by Harris (1994), is to allow one element of the set to be identified as the *head*. Headedness plays a major role in the formulation of phonological constraints and processes, especially prosodic processes. I shall mark the head by underlining it.

GP theories generally assert that constituents are at most binary branching, so that the main prosodic structure above the skeletal tier is (in Harris, 1994) syllable = (onset,rhyme), onset = (CC), rhyme = (nucleus,C), nucleus = (VX). More recent theories assert much stronger constraints, claiming for example that all ‘syllables’ are simply CV.

## 3 Representing Taa phonemes with elements

### 3.1 Standard GP elements

In our base formalism of Harris (1994), there are ten elements representing various phonetic aspects, though this number is reduced in later theories. In the original (Kaye et al., 1985) versions, elements had inherent meanings quite closely related to traditional features. Harris preferred to try to associate the inherent properties of elements with characteristics of the acoustic signal, and in particular of the spectrum. This is the reason for some of the names below. However, I am not here concerned with the discussion about the inherent properties of elements.

The ten elements, together with the sounds they characterize, are:

- **A**: ‘mass’, low back vowels, back-of-velar consonants
- **I**: ‘dip’, high front vowels, palatal consonants
- **U**: ‘rump’, high rounded vowels, labial consonants
- **@**: ‘neutral’, mid vowels, velar consonants

- **R**: ‘coronal’, coronal consonants
- **h**: ‘noise’, released stops, fricatives
- **?**: ‘stop’, stops
- **N**: ‘nasal’, nasal consonants, nasalized vowels
- **L**: ‘slack’, voicing in consonants
- **H**: ‘stiff’, aspiration, breathiness

Because of the distinct C and V elements occupying the skeletal tier, it is possible to use the same element combination for both a vowel and a consonant.

Before considering clicks, I will address the non-click inventory.

### 3.2 Elements for Taa pulmonic consonants

The representation of most of the consonants follows standard definitions. Labials, coronals, palatals, velars and uvulars contain respectively the **U**, **R**, **I**, **@** and **A** elements. The stops contain **?** and **h**; the fricatives just **h**; and the continuants neither. Nasals have **N**. Voicing comes from the addition of **L**, and aspiration from **H**.

The two slightly problematic issues are ejectives, and the two types of coronal consonant. Standard GPs have not properly addressed the representation of ejectives and other glottalized segments. In that context, a fairly natural suggestion is to use headedness, by stipulating that in an ejective stop, the element **?** becomes the head. Thus, /t/ is {**R**, **h**, **?**}, while /t'/ is {**R**, **h**, **?**}. This suggestion is made by, for example, Bércecs and Huber (2009), although Bellem (2007) rejected it; she, however, used additional structure (‘element geometry’) beyond simple headedness to solve the problem. (Element geometry is analogous to feature geometry: instead of just (headed) element sets, one has a tree structure imposed on the elements comprising a sound.)

The two places of coronal consonant (/t/ and /tʰ/) are a little more delicate. There is some disagreement about how they should be seen. Most, following Traill (1985), treat them as basically dental and alveolar series, with the affrication being a secondary cue. Güldemann (2001/2016), however, views them as unaffricated and affricated dentals.

A standard way of representing affricates in GP is to say that their **h** element becomes the head (intuitively, increasing the strength of the ‘release’ prime), so that /t/ is {**R**, **?**, **h**}, while /tʰ/ is {**R**, **?**, **h**}. While by itself this is unproblematic, it cannot be simply combined with the previous suggestion that ejectives are **?**-headed, since GP allows only one head, and there are ejectives /t'/ and /tʰ'/.

Similarly, dental/alveolar distinctions are sometimes represented by varying the headedness of the **R** element, an option which is problematic for the same reason. I am not aware of any proposed GP analysis for languages with a dental/alveolar–pulmonic/ejective contrast. I shall therefore adopt for the particular case of Taa a slightly unusual approach, motivated by one of the phonological behaviours of these two stop series: I shall say that the dentals also contain the element **I**. Normally, this would be a way of representing an alveolo-palatal or a palatalized dental; however, it turns out that in Taa, the dentals display a fronting or raising behaviour (see below) that the alveolars do not, and so it makes sense for them to contain **I**.

### 3.3 The representation of pure clicks

Clicks have not been carefully considered by element theorists; when they are mentioned (e.g., van der Hulst, 2006), it is usually assumed that there is an additional element characterizing them. However, though this may be described as *ad hoc*, it is in accord with the original principles of element theory. Clicks are certainly very saliently distinct from all other sounds, and so devoting a phonological prime to them should be acceptable to even the strongest proponent of parsimony. I shall therefore assume an element **K** (‘click’: ingressive burst) whose presence characterizes clicks.

It remains to be determined how the different places of anterior closure are realized. The alveolar click /!/ is cross-linguistically the commonest click, also the loudest and most ‘click-like’, in the sense of being perceptually unlike any pulmonic or ejective sound: it is a natural candidate for the meaning of the singleton element set {**K**}. Then the labial /ǂ/ is naturally {**K**, **U**}. The term ‘palatal click’ suggests that /ǃ/ should be {**K**, **I**}. Since the phonological behaviour of /ǃ/ also motivates the presence of **I**, I will adopt this representation.

The dental /!/ might be thought to be {**K**, **R**}. However, as with the dental pulmonics, there is fronting or raising behaviour which suggests the presence of **I**; thus I propose {**K**, **R**, **I**}.

Finally, we have the lateral alveolar /!/. Although the anterior closure is laterally released, the click does not (in any language) show any phonological behaviour typical of laterals. Since in Taa /!/ does *not* show the fronting/raising behaviour that /!/ does, the analogy with the pulmonic coronals /t, ts/ continues to hold, suggesting just {**K**, **R**}.

### 3.4 The representation of accompaniments

The preceding discussion addressed only elements characterizing the anterior closure of the click. A natural proposal is that the accompaniments are represented by elements giving the required laryngeal etc. modifications, together with those for the stop. Thus each accompaniment includes ? and **h**; voiced accompaniments include **L**; aspirated, **H**; nasal, **N**; and ejectives are marked by heading ?.

Since I have arranged for there to be no overlap between the elements used in accompaniments and those used for the pure clicks, and have moreover avoided the use of heading in pure clicks, the elemental description of a classical Taa click phoneme is simply the union of the pure click and the accompaniment.

### 3.5 The representation of vowels

The vowels are not the main focus here, so I shall not attempt a definitive solution. The basic five-vowel system would standardly be represented by taking /i, e, a, o, u/ to be {**I**}, {**I**, **A**}, {**A**}, {**U**, **A**}, {**U**}. Then breathiness is represented by adding **H**, and creakiness by adding ?.

The problematic issue is pharyngealization. The pharyngeal element is **A**, but this also represents the /a/ vowel itself. Given the need to distinguish plain and pharyngealized /a, o, u/, there is no adequate solution without going beyond the standard theory. As a ‘hack’, one might use headedness: thus /a, o, u/ = {**A**}, {**U**, **A**}, {**U**}, {**U**, **A**}, {**U**, **A**}, but all possible such solutions are artificial.

My preferred solution within the standard framework would be to abandon the parsimony of proposing that **A** includes pharyngeality, and add a new element for it. Going beyond the standard, the problem is easily solved by element geometry techniques (Bellem, 2007).

## 4 Prosody and Taa clusters

As I noted, Harris (1994) posits a binary branching structure for the prosodic level of phonology: a syllable  $\sigma$  is an onset and a rhyme, an onset may be (at most two) consonants, and a rhyme comprises a nucleus of one or two vowels, and a coda. Consequently the skeletal tier is formed of repeating units of (C)(C)V(V)(C)(C).

Much current formal work in GP works in ‘Strict CV’ (originating from Lowenstamm, 1996), in which it is asserted that the skeletal tier is formed entirely of repeating CV units; the mismatch with the surface is dealt with by some of these slots being associated with no melodic elements, and thus being empty of content. I shall not follow Strict CV; the challenges posed by Taa are already considerable for the standard theory.

Assuming that the initial clusters of Taa are indeed clusters, and further assuming that the final syllabic nasals of Taa are vocalic, then the prosodic structure of Taa lexemes is (C)(C)V(C)(V), which appears to be consistent with standard GP. However, it is not actually so, because standard GP imposes a universal restriction on branching CC onsets, in order to capture the linguistic universal that the second component of an onset cluster is weaker in obstruence, or stronger in sonority, than the first. The exceptions, such as stop–stop initials in Russian, give rise to many debates, but are typically analysed as containing an empty syllable nucleus.

The way standard GP encodes this constraint on branching onsets is via more fundamental principles. The first involves the notion of *licensing*: it is stipulated that in any phonological domain, any realized constituent must be licensed: either it is the *head*, or the head *governs* it. The second principle is that a governor must be at least as complex as any of its governees, where complexity is measured by counting the number of elements. Finally, the government operates in only one direction in a given domain, and in onsets it operates left-to-right. So, for example, the English onset /tr-/ is licit, because it has the structure CC, with /r/ licensed by the head /t/, and /t/ = {**R**, **?**, **h**} is more complex than /r/ = {**R**}. On the other hand, /rt/ is not a possible onset, because /r/ may not govern /t/.

Taa does have initial clusters that are indisputably in violation of the onset constraints: the pulmonic clusters such as /tqʔ/. These should probably be treated accordingly, with the /t/ being the onset of an empty syllable; and indeed, they are pronounced by releasing the /t/, arguably resulting in a fleeting voiceless vowel before the uvular.

The more interesting case is the click clusters, such as /!qʰ/. I proposed above that the click /!/ with the voiceless accompaniment is {**K**, **?**, **h**}, with three elements. The consonant /qʰ/ is {**A**, **?**, **h**, **H**} with four elements, and so the cluster /!qʰ/ fails the complexity condition; but it is not obviously different in any meaningful way from /!q/, which does not.

A key difference between the pulmonic clusters and the click clusters is that the click clusters geminate the posterior closure of the click with the closure for the uvular obstruent, so that in fact the click accompaniment is not released. This apparently exacerbates the violation of the complexity condition, as it removes the **h** from the first component of the cluster.

Within the standard framework, I am therefore forced to insert an empty V slot between the click and the uvular obstruent. While this is a routine procedure in GP theories, in this case it presents a particular obstacle to analysing one of the most interesting phonological phenomena of Taa, which we shall now discuss.

## 5 The A-Raising rule in Taa

Traill (1985) describes a phonological process in Taa that raises /a/ in certain environments. This process interacts with the well known Khoisan Back Vowel Constraint, also formulated by Traill, but can be analysed independently.

In Bradfield, 2014 I discuss the A-Raising Rule at length, and present a formulation that is not quite the same as Traill's, but which, I claim, is supported by the available recordings. The formulation is in *SPE*, but informally is thus:

- (1) A plain, breathy or creaky /a/ in the first mora is subject to raising when the second mora contains /i/, or is a nasal, *and* the onset of the first mora is a dental pulmonic, or a click cluster containing /l, ʔ/, as follows:
  - a. If the second mora is simply /i/, *and* the first mora onset does not contain a uvular obstruent, then /a/ raises to [i];
  - b. otherwise, /a/ raises to [ɜ].



For example: /!ai/ and /bai/ do not change; /!qai/, /lan/ and /!q'an/ raise /a/ to [ɜ]; and /!ai/ and /tai/ raise fully to [lii, tii].

Thus the raising requires both the presence of a following /i/ (the natural source of the raising), and the support of a preceding consonant of an appropriate type. The reasons why such support is provided by /l, ʃ/ but not /!, ʎ/ are discussed by Traill (1985) and further by Bradfield (2014); the details need not concern us here, but are simply incorporated into our analysis by including the **I** in the former two clicks. Moreover, the raising is *partly but not completely* blocked by the presence of a uvular obstruent in the initial click cluster.

Consider an example such as /!qai/ → [!qɜi]. If, as suggested above, click clusters have an empty V slot between the click and the obstruent, then the word is represented as in Figure 1 (in standard notation where vertical lines show the association of elements on different tiers of the autosegmental representation), where I conflate ? and **h** to save space.

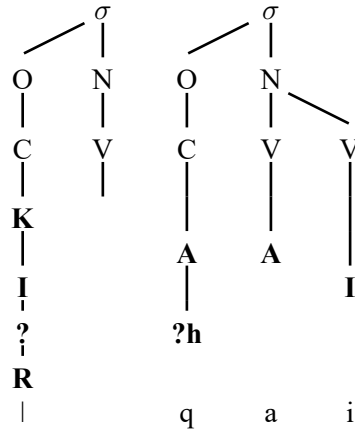


Figure 1: Representation of /!qai/

This prosodic structure relies on several basic principles of GP to be licit. Because the empty V is empty, it can't be the head of a higher level prosodic domain, and must therefore be licensed by another constituent, namely the following C (which is the /q/ of the cluster). Then the initial click C is itself licensed by the empty V—in general, onsets are licensed by nuclei, and syllables license other syllables, so that the initial degenerate syllable CV is licensed by the main, realized, CVV.

Now, an adequate description of the raising must involve the final **I** spreading backwards on to the previous V slot, and this rule must also require licensing from the **I** in the initial click. However, standard GP has a *locality principle*, which prevents a constituent from licensing a non-adjacent constituent on the same level: licensing is not allowed to ‘jump over’ constituents. Thus the locality principle prevents any licensing power transferring from the C of the initial ‘syllable’ to the V of the second ‘syllable’. It is possible to achieve non-local licensing if the constituents are heads, and so can be seen as adjacent at some higher level of the prosodic hierarchy (by *projection*), but this is not the case here.

## 6 Concurrency in GP

The same difficulty arises in an *SPE*-style analysis, although it is arguably less critical, because *SPE* does not have a locality principle built in: long-distance licensing is unnatural, but not outright forbidden. In Bradfield, 2014 I use this as an argument for my concurrent phoneme claim: if /!q/ is really /!( ⊗ q)/, then both components are adjacent to the vowel in the (concurrent) phoneme string, and so both the raising effect of the click and the blocking effect of the uvular obstruent are local phenomena. In the *SPE* formalism with concurrency, it is straightforward to encode the A-Raising Rule as stated above.

Applying the same idea in GP is somewhat similar to introducing element geometries. In element-geometric approaches, the elements associated with a particular skeletal slot are organized in such a way as to give internal structure to the ‘phoneme’ that is the result of the association—I briefly discuss one such alternative proposal later.

My GP formulation of my ‘concurrent’ approach is more radical, however. To capture the notion that the pure click and the accompaniment are happening in parallel at the segmental level, I do not treat the click as a complex consonant; rather, I assert that the skeletal tier itself is parallel rather than strictly sequential, and specifically that the Taa onset comprises two ordinary consonant slots in parallel with a ‘click slot’: instead of  $O = (C)(C)$ , we say  $O = ((K) \otimes (C)(C))$ .

Graphically, we represent this as in Figure 2.

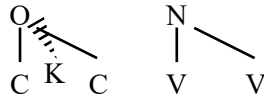


Figure 2: *Concurrent tiers*

Thus the pure click *K* is immediately adjacent to the first vowel of the following nucleus; the click accompaniment takes the first *C* slot of the onset, so is not adjacent; and the uvular obstruent takes the second *C* slot, and so is adjacent as usual.

Hence we can formulate the rule that *I* spreads backward onto a preceding *A*, provided this is licensed by an *I* in an immediately preceding consonant (partial A-Raising); and moreover that the original *A* de-links (so is deleted) if this is licensed by the presence of two immediately preceding *I* elements (full A-Raising). Moreover, the artificiality of the empty nucleus is avoided.

We can also observe that this formulation does indeed implement the idea of ‘concurrent phoneme’, even in a theory where phonemes are emergent rather than stipulative. In GP, a phoneme is the set of elements associated to a point on the skeletal tier, and by allowing the skeleton to have parallel *K* and *C* slots, we see that the pure click and the accompaniment are both phonemes in this sense.

## 7 Related work

The phonological structure of Khoisan clicks is a question that has provoked a range of suggestions. As we mentioned above, Traill (1993) was the first to consider internal structure to clicks, with a feature-geometric approach. Gldemann (2001/2016) took this much further, with an analysis involving a rich feature geometry, and some (not completely defined) notion of sub-segments that are themselves segments.

The first version of this work was presented as Bradfield, 2012. In response, Polgrdi (2014) has proposed an alternative representation in GP of Taa clusters. She takes an element-geometric approach, so that the anterior and posterior closure elements are associated to two different ‘root’ nodes, each associated to the relevant skeletal slot. She then accounts for CC clusters by saying that the posterior closure spreads so that it also links with the second skeletal slot. This does not, therefore, include any aspect of the concurrency inherent to my approach, and indeed leads rather in the opposite direction. An account of A-Raising awaits the full version, so it is as yet unclear how the problem of licensing will be overcome. However, she works in a strict CV theory, and it may be that such theories are more relaxed.

## 8 Conclusion

My account here shows that it is possible to give a reasonably natural GP account of Taa (and hence of other Khoisan languages), while also incorporating the novel idea of concurrency. The account preserves all the claimed advantages of concurrency in terms of inventory size, learnability, etc., since concurrent

phonemes emerge from it just as standard phonemes emerge from standard GP. It also allows a natural account of Taa phonological phenomena.

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