On the Representation of Clicks

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0. Introduction

At the level of phonetic description, click consonants involve a double articulation, and a timing of articulatory gestures which results in an ingressive, velaric airstream mechanism. Phonological analyses regarding the linguistic representation of clicks vary in the status - major or minor - they afford each of the two place of articulation specifications. These segments are typologically unusual in that they occur only in certain language families of southern and eastern Africa. This paper combines information about the phonetic description and phonological patterning of clicks, with typological universals of doubly articulated segments, to argue that clicks are back consonants with a secondary front closure.

The most complex and extensive inventory of click consonants described in the literature is found in !Xóõ, a Bushman language spoken in Botswana and Namibia. This language has a total of 80 distinctive clicks, being almost double the number of clicks in Zu/ʔhoãsi (also known as !Xu), the next most extensive click language. Due to this complexity, !Xóõ is a particularly interesting language to study, and owing to the extensive fieldwork of Dr. Anthony Traill, data on this language is readily available. For these reasons, this paper will focus primarily on data from !Xóõ.

The remainder of this paper is structured as follows. In section 1, I provide a brief phonetic description of clicks. Section 2 reviews the main points of the various phonological feature analyses of clicks. Section 3 discusses the notion of primary and secondary articulations and how it bears on the representation of clicks. This section also proposes an analysis of clicks in which they are represented as back consonants with a secondary front articulation. Section 4 discusses the clicks of the Khoisan language, !Xóõ, and their relationship to the non-click consonants of the language. The comparison of the click and non-click systems of this language will be shown to provide further support for the analysis proposed in section 3. Finally, section 5 provides a summary and conclusions of the discussion.

1. Phonetic description of clicks.

In the articulation of clicks, there are two points of closure: one towards the front of the oral cavity and one farther back. The familiar and well described (Beach 1938, Ladefoged

1975, Traill 1985) mechanism by which a click is produced involves the influx of air into the oral cavity upon the release of the front closure. This occurs as a result of the decrease in air pressure in the space between the lowered middle part of the tongue and the roof of the mouth. The lowering of the tongue is a suction movement which causes the rarefaction of the air between the two closures. The release of the back closure is achieved with the efflux of a pulmonic or glottalic airstream. A requirement for the articulation of clicks is that both closures are in place before the lowering of the tongue body, and that the front closure is released prior to the release of the back closure. It is precisely this ordering of events, in conjunction with the suction movement in the oral cavity, which produces the influx of air which we hear as a "click."

Palatographic studies of the clicks of !Xóõ presented in Traill (1985) show the five influx places of articulation. These can be described as bilabial, dental, post-dental/alveolar, palatal and lateral. Traill avoids the term "alveolar" since a common physiological feature of the San population is the absence of a conventional alveolar ridge; in this population the palate tends to slope back smoothly. Examples of each of the five places of articulation for the front closure of the clicks in !Xóõ are given below, along with their IPA symbols.

Table 1. Examples of the 5 influxes in !Xóõ (Traill p 124)

	symbols	example	gloss
bilabial	ʘ	ʘôõ	'dream'
dental	ǀ	ǀâa	'move off'
post-dental	ǂ	ǂàã	'knock'
palatal	!	âã	'wait'
lateral	ǁ	ǁáã	'poison'

An articulatory distinction between the dental and post-dental clicks on the one hand and the palatal and lateral clicks on the other, is that the former are laminal whereas the latter are apical. Another phonetic detail which sets the labial, dental and lateral clicks apart from the post-dental and palatal clicks is that the former are released with friction whereas the latter are released instantaneously. These phonetic distinctions are summarized in table 2 below. Traill observes 16 distinctions along the place and manner dimensions for the articulation of the back closure in the clicks of !Xóõ. There is a contrast between a velar and uvular place of articulation and the efflux may be achieved with varying degrees of closure, oral or nasal voicing, pulmonic or glottalic airstreams and various degrees of aspiration, which can precede, follow or be simultaneous with the release. Combined with the five possible influxes this yields a total of 5x16=80 clicks in this language.

Table 2. Phonetic features of the influxes.

	apical	laminal	fricated release
labial	-	-	+
dental	-	+	+
post-dental	-	+	-
palatal	+	-	-
lateral	+	-	+

A crucial phonetic detail in the production of clicks is the relative timing of the closures and releases of the front and back articulations. Maddieson and Ladefoged (1989) discuss the possible timing relations of multiply articulated segments such that both articulations are audible and neither is subsumed by the other. Figure 1 below provides a schematic diagram of the possible timing relations.

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(1) (a) dorsal  |----------|              (b) dorsal  |------------------|
        coronal      |--------|                coronal      |----------|
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In the case of non-click, multiply articulated segments the relative timing of the two gestures is necessarily as shown in figure (1a), where the solid lines indicate the duration of the coronal and dorsal closures respectively, in undefined units of time. This timing is required in order for there to be robust cues to the existence of two separate, articulatory gestures. In the case of clicks, the timing of the two gestures is as shown in (1b). The back closure must be in effect throughout the articulation of the front closure in order to facilitate the characteristic velaric airstream mechanism. It is the click sound which results from the velaric airstreams which provides the phonetic cue to the presence of a multiple articulation. In the simplest case, the release of the back closure will take place immediately after the release of the front closure. In this case the onset of the following vowel occurs immediately after the front release. This is the case of the "basic" click with the unaspirated, voiceless velar stop accompaniment. Similarly, the nasal and voiced clicks, display an essentially immediate onset of the following vowel. The rest of the click accompaniments involve the production of phonetic material which is audible between the suction, clicking sound and the onset of the following vowel.

2. The phonological feature analysis of clicks.

In "Preliminaries to Speech Analysis," Jakobson, Fant and Halle (1963) provide very brief comments on the feature specifications for clicks. In their system, clicks, and other doubly articulated consonants are "...but special forms of consonant clusters. They are extreme cases of co-articulation" (page 23). Thus in this system there is no need for a special feature [suction] for it is the timing of the releases and their extreme contraction in time which produces the influx. Similarly, the issue of primary and secondary articulations is not relevant in this feature system since clicks are treated as consonant clusters.

Trubetzkoy (1969) treats clicks as a correlation that arises as a result of a secondary series of localization entering into an opposition with its corresponding basic series. The click correlation is distinct from the correlations of palatalization, velarization and labialization in that the latter are all correlations of timbre with specific, vocalic-like "colorings," whereas the suction property of clicks is accounted for as a phonetic detail. The supplemental velar closure which is present in all click consonants is the feature which is of phonological importance, however it is distinct from the correlation of velarization in that the closure is consonantal, rather than vocalic, in nature. Trubetzkoy points out that a velar closure is present in the gutturalized and labiovelarized consonants of other languages, "though perhaps not in quite as energetic a form." (p. 138) This view of clicks as consonants with a special type of secondary articulation is the precursor to the view taken by Chomsky and Halle in S.P.E. And, the observation that a parallel can be drawn between the inventory of click and non-click consonants within a language is echoed in Traill's (1985) study of !Xóõ.

In SPE, Chomsky and Halle introduce the feature [suction]. They characterize clicks as ".. noncontinuants with extreme velarization" (p. 319). Thus in this feature system, clicks are treated as consonants with secondary velarization. The feature [suction] is classified as a manner of articulation feature which involves a supplementary movement. A specification of [+suction] is the mark of a movement within the vocal tract which results in a decrease in pressure at the time when both closures have been achieved. It is in opposition to the feature specification [+pressure] which indicates a movement in the vocal tract which results in an increase in supraglottal pressure. The introduction of this feature into the SPE system provides a means of distinguishing click consonants from other multiply articulated consonants. For example, they note that the Guang languages have consonants which, according to Ladefoged, combine a labial and velar articulation with no suction. The Yoruba labio-velars are intermediates between the Guang type of doubly articulated consonants and the true clicks in that they involve a movement of the back articulator which decreases the oral cavity pressure and results in a suction feature of the front closure. However, this is achieved while there is still an outward flow of air from the lungs. In other words these doubly-articulated segments are produced with a combination of ingressive and egressive airflow. The sequencing of closures and releases for the true clicks is such that the suction is achieved while the back closure is still in effect and the flow of air upon release of the front closure is ingressive. Thus in this system the feature [suction] distinguishes different types of multiple articulations, and clicks are treated as [+suction] consonants with secondary velarization.

In his study of the !Xóõ language, Traill (1985) also adopts the feature [suction] as a means for distinguishing the click consonants from the non-click consonants. He concludes his study with the proposal that clicks be considered as clusters of independent consonants. His primary argument in favor of the cluster analysis is that all of the click effluxes exist in the language as independent consonants, some of which combine with other consonants to form non-click clusters. By analyzing clicks as clusters of consonants, the consonant inventory of !Xóõ is dramatically reduced in size, bringing it more in line with the majority of the world's languages. Note however, that the feature specification [+suction] is still necessary under the cluster analysis in order to distinguish the voiceless unaspirated, voiced and nasal clicks, that is the clicks which are articulated without any distinctive markings on the efflux, from their homologous non-click counterparts. In the examples in (2) the feature [suction] distinguishes the first segments of each pair.

(2) (a) voiceless, unaspirated:	ǀaa	'move off'	taa	'person'
(b) voiced:	ǀgaa	'work'	dam	'hunger'
(c) nasalized:	ǀnaa	'see you'	n	'I'

Although Traill is correct in his claim that the consonant inventory of !Xóõ is drastically reduced under the cluster analysis, this analysis is not without shortcomings. Firstly, a result of this analysis is that this language has extremely complex clusters which is a typological rarity in itself. Furthermore, in this analysis, as it is presented by Traill, the back articulation of clicks is treated either as a phonetic detail, as in the case of the voiceless unaspirated, voiced and nasal clicks, or as an independent consonant which follows the click. However below I present evidence from the phonological patterning of clicks with other back consonants, that the back articulation for all clicks is phonologically relevant.

In this language there is a constraint which applies to vowels following back consonants. The underlying vowel inventory of !Xóõ consists of five basic vowel contrasts, namely /i, e, a, o, u/, however following a back consonant all vowels will appear on the surface as [a, o, or u]. This "Back Vowel Constraint" can be formulated as in (3).

With few exceptions all the click consonants exert this effect on following vowels, indicating that clicks and back consonants form a natural class which can be characterized by the feature specification [+back].

(3) Back Vowel Constraint

If	C_1	V_1	
	[+back]		
then	C_1	V_1	
	[+back]	[+back]	(Traill '85, p90)

In Traill's analysis of clicks as consonant clusters, he draws a distinction between the "basic" clicks, that is the voiceless unaspirated, voiced and nasal clicks, and all other clicks. Basic clicks are those which lack prominent features on the release of the back closure and which are thus not analyzed as clusters of independent consonants. All other clicks have audible release features on the back closure which, under the cluster analysis, are considered to be independent consonants which follow the "basic" click. This analysis fails to capture the linguistic significance of the back closure of the basic clicks with respect to a phonological process in the language, the Back Vowel Constraint, since it treats the closure at the velum for these clicks as a phonetic detail which is required for the production of the influx. Thus, contrary to the phonological feature specifications we expect from Traill's analysis, the specification [+back] must be added to the feature characterization of the simple clicks if we still wish to maintain a cluster analysis of clicks and their accompaniments. In other words, we have demonstrated the necessity of specifying a double articulation for even the basic clicks. However the status of the back articulation as a primary or secondary articulation still remains to be resolved.

In the analysis proposed by Sagey (1986), clicks are complex segments which have the back closure as the major articulator and the front closure as the minor articulator. In Sagey's representation, the distinguishing mark of a click is a velar closure as the major articulation in the complex segment. The mechanism by which the major and minor articulations in a complex segment are specified is directly related to the phonological degree of closure features of the segment. The major articulation will receive the degree of closure associated with the segment and therefore is able to enter into oppositions based on these features. The minor articulation, on the other hand, will have predictable stricture features associated with it. So, for example in !Xu, Sagey distinguishes clicks from all other corono-dorsals by having the dorsal articulation as major. For [tx] the dorsal articulation has predictable (i.e., always fricated) degree of closure, whereas for clicks, the coronal articulation has predictable degree of closure. (As in !Xóõ, the degree of closure of the front articulation is predictable from the place specification, as shown in table 2). Thus we have the representations shown in (4) to distinguish [ǂ] from [tx] in !Xu. The crucial difference is in the articulation being pointed to by the pointer which identifies the major articulator. In the case of [tx] the coronal node is pointed to, whereas for the click, [ǂ], the feature dorsal is the major place of articulation. This representational system uniquely specifies clicks within the language by having the dorsal articulation as the major articulator. Furthermore, in this way the feature [suction] is rendered redundant.

```
(4)    [tx]            [ǂ]
     ┌ [-cont]         [-cont]   ┐
     │   |               |       │
     │  root            root     │
     │   |               |       │
     │  supra           supra    │
     │   |               |       │
     │  place           place    │
     │   /\              /\      │
     └> cor dors       cor dors <┘
```

An important characteristic of Sagey's theory is that she draws a distinction between major and minor articulations, and avoids the terms "primary" and "secondary". In her feature system a major articulator is defined as "... an articulator to which the phonological degree of closure features of the segment apply" (p. 203). A minor articulator will always have a degree of closure which is predictable within the particular language. This characterization of major and minor articulators allows for the possibility that minor articulators are of an equal, or even greater, degree of closure. Indeed, there are cases of multiply-articulated segments for which the articulator with distinctive degree of closure shows a lesser degree of closure than the other, minor articulator. For example, Sagey cites the corono-labial segments in Margi, /ps/, where the non-continuant, labial articulator has a non-distinctive degree of closure and the continuant, coronal articulator contrasts for degree of closure. When applied to clicks, Sagey's feature theory provides a straightforward means of capturing the predictable degree of stricture of the front closure. And, since this theory allows for the possibility that the minor articulator shows a consonantal type of closure, the problem of a non-vocalic secondary articulation is avoided.

Sagey also presents an argument from the point of view of phonological processes in favor of her proposal. In her theory, complex segments involve two articulations which are represented under one x-slot and thus occupy only one unit of phonological timing. Unlike contour segments, the two articulatory gestures of a complex segment are phonologically unordered relative to each other. The segment as a whole is subject to linguistic rules which affect either of the features represented at the subsegmental level. Moreover, a complex segment with two, unordered place features, say F and G, may behave as an F segment with respect to its right edge for the purposes of one rule but as a G segment with respect to that same edge for the purposes of another rule. Clusters, on the other hand, are strictly ordered and will behave as such with regard to phonological processes.

Sagey claims (p. 126) that the !Xóõ clicks display exactly the type of behavior expected of complex segments with respect to phonological processes. In this language there is an assimilatory process which raises and fronts the vowel /a/ when it is followed either immediately or after an intervening consonant by /i/, or by /n/, and is preceded by a dental consonant. For the purposes of this rule, the click, /ǂ/, patterns with other dental consonants such as /t/ and /l/. This rule with examples are given in (5), (Sagey p. 127).

(5) Dental Assimilation
a -> ɜ, ɨ / dental ____ i, n
/tan/ [tɜn] 'to it' (Traill p.73)
/ǂali/ [ǂɨli] 'fold ' (Trail p.70)

Thus the click /ǂ/ behaves phonologically according the place features of its front closure at its right edge. However, for the purposes of the !Xóõ "Back Vowel Constraint" this same segment behaves according to the feature specifications of the back closure at its right edge. So, the patterning of /ǂ/ with other dental consonants with regard to the dental assimilation rule and its classification as a back consonant from the point of view of the "Back Vowel Constraint", is presented by Sagey as evidence that this click must have two, phonologically unordered places of articulations, making it a singular, complex segment.

A weakness of this analysis of clicks as complex segments is with regard to the interaction of the place specifications and the following vowel as evidence for unordered multiple articulations. In a feature geometry which has different place features specified on different tiers, any feature of a given segment is accessible to non-adjacent segments on the segmental tier for rule interaction so long as there is no intervening specification on the tier in question. For example, in a $C_1C_2V_1$ sequence in which C_1 has a specification [+F] for some feature F, and C_2 is specified [+G] for some other feature G, both of these feature specifications are accessible to V_1 without violation of the prohibition against crossing association lines. The adjacency of C_2 and V_1 on the segmental tier makes this observation trivial for the interaction of the feature G with the following vowel. The lack of a [-F] specification for C_2 which would block the interaction of C_1 and V_1 makes the observation true for the interaction of the feature F and V_1. The case of clicks in the Khoisan languages is exactly analogous to the example discussed above whether the accompaniment is taken to be an independent consonant or if clicks are analyzed as unitary segments. Thus Sagey's argument based on phonological patterning in favor of clicks as complex segments is not completely compelling, although it has certain strong points.

In contrast to the analyses in which the two articulators of clicks are treated as either two independent segments (e.g. Jakobson, Fant and Halle , Traill), or one major (primary) and one minor (secondary) articulation (e.g. Trubetzkoy , Chomsky and Halle, Sagey), Maddieson and Ladefoged (1989) claim that neither of the two click articulators is less major, or less primary, than the other. They therefore treat clicks as multiply articulated segments with two primary (or major) articulators. However, their arguments are mainly in favor of viewing the back articulator as primary rather than as secondary, as proposed in SPE. They do not discuss the possibility of viewing the front articulator as secondary to the primary back articulator.

3. Clicks as back consonants with anterior secondary articulations revisited

This section presents a modified version of Sagey's feature representation for clicks, in which the front articulation is secondary to the back articulation. We then examine further some of the characteristics of primary and secondary (or, major and minor) articulations as they are characterized by the proposed structure, and show how they bear on the status of the click articulations within the sound structure of !Xóõ.

Clements (1991) proposes a feature geometry in which the place node of a segment splits into two lower level nodes. The higher level node is termed the consonant, or C-place node, while the lower level node is referred to as the vocalic, or V-place node. A segment may bear features on just the C-place node (i.e. plain consonants), on just the V-place node (i.e. vowels), or on both the C-place and the V-place nodes (i.e. consonants with a secondary articulation). The abbreviated tree structures in (6), based on Clements (1991) show the representations for [t], [i] and [tʸ].

```
(6)        [t]              [i]                [t^y]
           root             root               root
            .                .                  .
            .                .                  .
           C-place          C-place            C-place
           /                 \                  / \
           [coronal]          \         [coronal]   \
                              V-place              V-place
                              /                    /
                             [coronal]           [coronal]
```

As discussed elsewhere (Clements 1991, Goodman 1990), motivation for this structure comes from the relatively free interaction of vowels across consonants, as opposed to the blocking effect of vowels on consonantal spreading. The above representation accounts for this fact by placing the V-place node under the C-place node. Furthermore, this representation provides a clear account of interactions between vowels and secondary articulations of consonants. For example, in Ponapean, labial consonants with a labiovelar secondary articulation, such as $/p^w/$, pattern together with back rounded vowels (Goodman 1990). Sagey's insight with regard to the non-contrastive degree of stricture of minor articulations can be captured in this system by assigning the contrastive degree of stricture to the place specifications under the C-place node in multiply-articulated segments. In this way there is no longer a need for the pointer, and the contrastive degree of closure of primary articulators versus non-contrastive degree of closure of secondary articulators is captured in an equally natural way. The representation for clicks in this theory is illustrated in (7) by the partial feature trees for [ǂ], and [ʘ].

```
(7)        [ǂ]                  [ʘ]
           root                 root
            .                    .
            .                    .
           C-place              C-place
            / \                  / \
      [dors]   \           [dors]   \
               V-place              V-place
                 \                    \
                 [cor]                [lab]
```

A prediction of this theory, which represents primary articulations under the C-place node and secondary articulations under the V-place node, is that interactions between parallel tiers (that is, interactions between two adjacent C- or V- place tiers) will be "stronger" than interactions between cross tiers (that is interactions between adjacent C- and

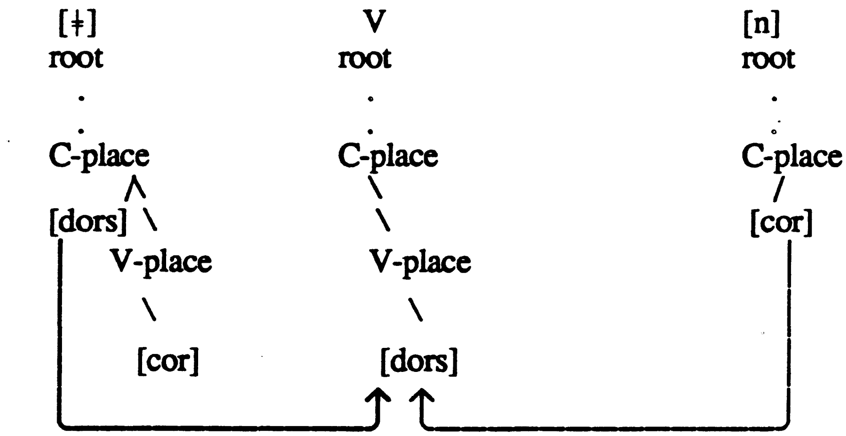
V-place tiers). As we will see below, by representing clicks as back consonants with labial or coronal secondary articulations, we can account for the difference between a partial and a total assimilatory process in a straightforward manner.

As discussed above, !Xóõ has a constraint which backs vowels following back consonants, including clicks. Thus after all back consonants the vowels will be taken from the set, [a, o, u]. This is a strong constraint in the language and will also apply to loan words, such as the Afrikaans word [dɔŋki] 'donkey' yielding [tonti] in !Xóõ. In this case, the final CV sequence, of which the consonant is [+back] and the vowel is [+front], is nativized by !Xóõ to yield two front segments. There is one class of exceptions to the Back Vowel Constraint which shows a regular assimilation of the vowel following a dental or post-dental stem-initial click, to the Class 1 noun suffix [-i]. This process results in an alternation of the stem vowel, as shown by the examples in (8). Apparently, the stem vowel in the singular form assimilates completely to the suffix vowel via a rule such as a→ i /{ǀ, ǂ} _ i (Traill, p. 91).

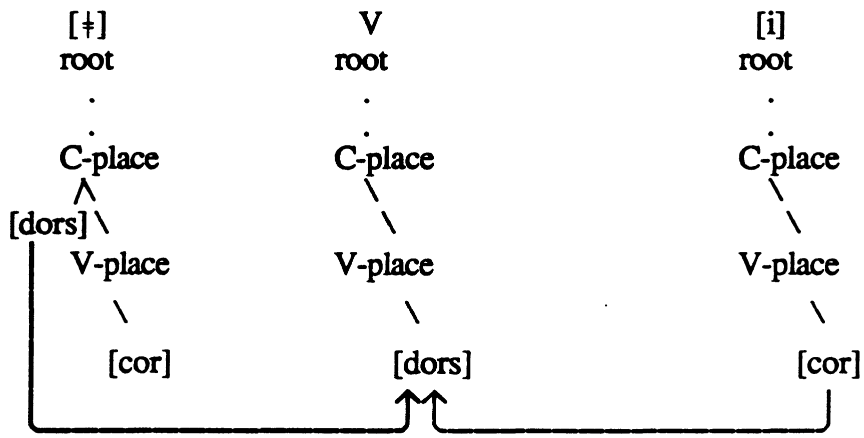
(8)	ǀʔi.i	'lover'	ǀʔa.ba+te	pl.
	ǀi.i	'steenbuck'	ǂa.ba+te	pl.
	ǂqhe.e	'bush'	ǂqha.m	

This language also has a co-occurrence constraint against a sequence of two vowels of which the first member is a coronal vowel, that is /i/ or /e/. Thus we have well-formed sequences such as /ai, ae, ui, ue, oi, oe/, whereas */ia, ea, iu, eu, io, eo/ are not permissible. This can be stated as a restriction against sequences of coronal and dorsal feature specifications on the V-place tier (*[coronal dorsal]$_{\text{V-place}}$). Now, in the case of the dental and post-dental clicks which have the coronal articulator represented under the V-place node, the Back Vowel Constraint would appear to create sequences which violate this restriction. In fact, these are precisely the cases where we find a relaxation of the Back Vowel Constraint in the form of the dental assimilation rule shown above in (5), and in the systematic exceptions to the Back Vowel Constraint in (8). Thus it appears that in these cases the *[coronal dorsal]$_{\text{V-place}}$ restriction receives reinforcement by the presence of an adjacent coronal segment to its right, which will spread its coronality to the vowel. Feature tree representations for these two interactions are given below in (9). The bold arrows connect the two tiers over which the Back Vowel Constraint operates. The unbolded arrows connect the two tiers which enter into the assimilatory processes.

(9)(a) Dental Assimilation



(b) Back Vowel Constraint exceptions



Recall that the assimilation of the dental assimilation rule is a rule of partial assimilation which causes the vowel to be centralized, whereas the examples in (8) show a total assimilation and the vowel surfaces as a front vowel. This difference in strength of the assimilatory process can be accounted for in this system of representation by appeal to the difference between cross- and parallel-tier interactions. The interaction in the dental assimilation rule when conditioned by a following [n], as shown above in (9a), occurs across tiers; the C-place coronal specification of the [n] interacts with the V-place specification of the vowel. In the case represented by (9b), the V-place - V-place interaction overrides the C-place - V-place interaction of the Back Vowel Constraint, resulting in apparent exceptions to this constraint. If the coronal specification of the click were represented as the primary articulator under the C-place node and the dorsal click specification were represented under the V-place node, then we would expect that the two interactions exert equal influence over the vowel in the examples in (8). However, this expectation is not borne out and it appears that this interaction is indeed a V-place - V-place interaction.

In the case of the dental assimilation rule conditioned by a following [n], the interaction of this rule and of the Back Vowel Constraint are both characterized by this representation as cross-tier interactions. We would therefore expect them to be of equal "strength," and this expectation is borne out by the fact that the assimilation is partial rather than complete as in the parallel-tier, V-place - V-place interactions of (9b). In fact, Traill notes that in certain cases where the dental assimilation rule is conditioned by a following vowel, [i], the target vowel may assimilate fully yielding a long [i:] (Traill p70). This is a result that we would expect given the proposed representation since this assimilation operates over parallel tiers. Furthermore, there is evidence to show that the assimilation can be suspended if there is a back vowel following the coronal consonant. For example, we find [ǂɨli] where the assimilation has applied and [ǂana] were the assimilation is blocked by the final [a]. Thus there is apparently a competition of assimilatory processes which results in alternating surface vowels. If the click consonant were represented with the back specification under the V-place node, we would expect the Back Vowel Constraint to override any other C-place - V-place interaction. In this case, the Back Vowel Constraint would be a "strong" V-place - V-place interaction and should show no interference from any C-place - V-place interaction.

To summarize this section so far, we have seen that a representation of clicks as back consonants with a secondary front articulation in a feature geometry which splits the place node into a C-place node with a lower level V-place node, provides a natural account for the predictable degree of stricture of the front articulator. Also, by having the front articulator represented as a secondary articulation under the V-place node, we can explain the differences in degree of assimilation between vowels and following consonantal and vocalic coronal segments. Thus we have evidence from phonological rules of !Xóõ in favor of an analysis in which clicks are back consonants with a secondary front articulation.

At this point it is interesting to consider various other properties of the proposed structure for multiply articulated segments. Given this feature geometry, we expect to find cases of complex segments which differ only in which articulator is selected as major and which is selected as minor. Indeed, as initially observed by Sagey for !Xu, the closely related !Xóõ contrasts the non-click complex segment /tx/ and the click /ǂ/. Both of these segments involve both coronal and dorsal articulations. The difference between them is precisely a difference in terms of which articulator is treated as primary. For the click it is the coronal articulator which shows predictable degree of stricture. For the non-click the situation is exactly reversed. In this case the back articulation is always fricated. Thus, for the non-click complex segments, the coronal articulator is represented under the C-place node and the dorsal articulator is represented under the V-place node. For clicks it is the dorsal articulator which appears under the C-place node. These opposing representations are given below in (10). Note how this representation allows us to avoid using the pointer of Sagey's theory.

```
(10)            [ǂ]                 [tx]
                root                root
                 .                   .
                 .                   .
               C-place             C-place
                 /\                  /\
            [dors] \             [cor] \
                 V-place             V-place
                     \                   \
                    [cor]              [dors]
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As noted above, Sagey's feature geometry allowed for the possibility that minor articulators show equal, or even greater, closure than major articulators. The defining feature of a minor articulator is that it does not bear distinctive degree of stricture features. In the theory proposed by Clements, this property of minor articulators is expressed by placing a secondary articulation under the V-place node, and by having the distinctive degree of stricture features of the segment apply to the place specification under the C-place node. The phonetic interpretation of the closure for the secondary, V-place features is determined in a language specific way. Note that in neither Sagey's nor Clement's feature system is the feature [suction] needed for the representation of clicks, since it is the distinctions between primary (or, major) and secondary (or, minor) articulations which defines the click segments phonologically. Thus the specific timing of the articulator closures and releases which results in the ingressive airstream mechanism is treated as part of the segment's phonetic interpretation.

A prediction of this analysis in both Sagey's and Clement's theories, is that no language will contrast two segments which differ only in either timing of the articulatory gestures or in degree of stricture of the minor articulator. This is because these properties of the segments are treated as part of their phonetic interpretations. For example, we expect that no language will contrast [k^y] and [ǂ]. Both of the segments are back consonants with secondary coronalization and thus have identical phonological representations. They differ in the degree of stricture of the secondary articulation; for [kʸ] the secondary articulation has a vocalic degree of stricture whereas for [ǂ] the coronal articulation is consonantal. Indeed, I know of no click language which has such a contrast.

Thus we have seen that a representation for clicks such that the back closure is represented under the C-place node and the front closure is under the V-place node, finds support from both linguistic processes and representational generalizations. The major advantage of this system over Sagey's system of feature representation is that it provides an explanation for certain asymmetries that are observed between consonant-vowel interactions and vowel-vowel interactions.

4. A closer look at the click and non-click systems of !Xóõ

A comparison of the click and non-click consonants of !Xóõ reveals some interesting properties of the general consonant system of this language. Traill observes that there is a parallel between the click accompaniments and the non-click consonants of the language, which is seen by the existence of almost all the click accompaniments as independent consonants. This fact is Traill's primary argument in favor of a cluster analysis of clicks. In this section, we examine this parallel between the clicks and non-clicks, and show that the analysis of clicks proposed in the previous section provides a natural system of classification for the !Xóõ consonant system which is consistent with cross-linguistic trends.

The clicks of !Xóõ show five influx places of articulation; bilabial, dental, post-dental, palatal and lateral. Amongst the non-click consonants we find bilabial, dental, and post-dental places of articulation, as well as a marginal lateral. However, there are no non-click palatal consonants. For the click back articulations we find a velar and uvular place of articulation. Both of these places of articulation are also found amongst the non-clicks. For both the clicks and non-clicks we find all four logically possible combinations of voicing and aspiration. In all cases voicing is realized as voice-lead and aspiration is realized as post-release aspiration. Table (3) shows these sets of consonants. Table (3a) shows non-click consonants which contrast along the voicing and aspiration dimensions. Table (3b) shows the clicks with a velar back closure and their variants with respect to voicing and aspiration. Table (3c) shows the corresponding series of clicks with a uvular back closure. Parentheses indicate that the segment is marginally present in the language and all orthographic conventions adopted by Traill are retained. Thus, *dth* represents a dental segment with prevoicing and post-aspiration.

Table (3)

(a) Non-click consonants:

	labial		dental		post-dental		velar		uvular	
	unasp	asp.	unasp.	asp.	unasp.	asp.	unasp.	asp.	unasp.	asp.
vcl	(p)	(ph)	t	th	ts	tsh	k	kh	q	qh
vcd	b		d	dth	dz	dtsh	g		(N)G	
lat.						(1)				

(b) Click consonants with a velar back closure:

	labial		dental		post-dental		palatal		lateral	
	unasp.	asp.	unasp.	asp.	unasp.	asp.	unasp.	asp.	unasp.	asp.
vcl	⊙	⊙h	|	|h	ǂ	ǂh	!h	!	||	||h
vcd	⊙g	g⊙h	|g	g|h	ǂg	gǂh	!g	g!h	||g	g||h

(c) Click consonants with a uvular back closure:

	labial		dental		post-dental		palatal		lateral	
	unasp.	asp.	unasp.	asp.	unasp.	asp.	unasp.	asp.	unasp.	asp.
vcl	⊙q	⊙qh	|q	|qh	ǂq	ǂh	!q	!qh	||q	||qh
vcd	m⊙ G		n|G		nǂG		n! G		n ||G	

Within the proposed representation for clicks, the non-click consonants in table (3a) are related to the clicks in tables (3b) and (3c) in that they are non-complex consonantal variants of the click double articulations. Thus the labial, dental and post-dental non-clicks in table (3a) are consonantal versions of the corresponding click secondary articulations. The velar non-click consonants in table (3a) are simply the click primary articulations in (3b) with no secondary articulations. Similarly, the uvular non-click consonants have their click counterparts which are shown in table (3c).

The next set of parallels between the click and non-click consonants is exemplified by those pairs of doubly articulated click and non-click consonants which differ in which is the primary and which is the secondary articulator. These consonants are shown in table (4).

Table (4)

(a) non-click segments with a secondary uvular fricative:

	dental	post-dental
vcl	tx	tsx
vcd	dtx	dtsx

(b) click segments with a uvular fricative accompaniment:

	labial	dental	post-dental	palatal	lateral
vcl	ʘx	ǀx	ǂx	!x	ǁx
vcd	gʘx	gǀx	gǂx	g!x	gǁx

Amongst the non-clicks we find that only the coronal segments bear the secondary articulation. The clicks, however, show both coronal and labial secondary articulations. Note that in all of the segments in table (4), following Traill, the uvular fricative is transcribed as [x] rather than [χ]. This reflects a traditional means of transcription and is therefore retained.

Table (5)

(a) ejected non-click segments:

	post-dental	velar	uvular
vcl	tsʔ	kxʔ	(qʔ)
vcd	dtsʔ	gkxʔ	

(b) click segments with ejected accompaniments:

	labial	dental	post-dental	palatal	lateral
	ʘqʔ	ǀqʔ	ǂqʔ	!qʔ	ǁqʔ
vcl	ʘkxʔ	ǀkxʔ	ǂkxʔ	!kxʔ	ǁkxʔ
vcd	gʘkxʔ	gǀkxʔ	gǂkxʔ	g!kxʔ	gǁx̌ʔ

(c) ejected non-click segments with ejected secondary articulations:

	dental	post-dental
vcl	tʔkxʔ	tsʔkxʔ
vcd	dtʔkxʔ	dtsʔkxʔ

The non-click system shows both voiced and voiceless ejected uvular affricates (transcribed as [kxʔ] and [gkxʔ]), a marginal ejected uvular stop and ejected post-dental segments. In the click system we find all of the above back segments with all five of the click front, secondary articulations. These series of clicks and non-clicks are shown in tables (5a-c).

Like the non-clicks in table (3a) which are the non-complex counterparts of the clicks in (3b), the velar and uvular consonants in table (5a) are the non-complex versions of the clicks in table (5b). This language also has ejected dental and post-dental non-clicks with ejected velar secondary articulations (table 5c). Thus, like the dental and post-dental plain stops with the secondary uvular fricative in table (4a) which contrast with the clicks in (4b), we find an opposition between the clicks in table (5b) and non-clicks in table (5c) based on which articulator is selected as primary. In the case of an ejected secondary articulation, (5c), we find that the primary coronal is ejected too.

For the non-click nasals we find plain and preglottalized bilabial and dental nasals. For the nasalized clicks we find plain, preglottalized and voiceless variants. Thus, for the nasal series, we find that the non-clicks correspond to the click secondary articulations. However the non-click system is less extensive than the click system since it lacks the voiceless variants. Table (6) shows these segments.

Table (6)

(a) nasal non-click segments:

	labial	dental
plain	m	n
preglott.	ʔm	ʔn

(b) click segments with nasal accompaniments:

	labial	dental	post-dental	palatal	lateral
plain	ʘ n	ǀn	ǂn	! n	ǁn
preglott.	ʔʘ n	ʔǀn	ʔǂn	ʔ ! n	ʔǁn
voiceless	ʘ n̥	ǀn̥	ǂn̥	! n̥	ǁn̥

The only remaining click accompaniment is the glottal stop, which has no reflex in the non-click system.

From the comparison of the non-click and click systems of !Xóõ, we see that the non-clicks can be related to the clicks in two different ways. Firstly, there is a set of non-clicks which exist as the plain (as opposed to complex) versions of the click primary and secondary articulations. Thus we have four of the five click influxes (secondary articulations) which exist as independent non-click consonants. And we find plain non-click velar and uvular variants of all of the clicks. The nasal click and non-click segments are also related in this way. That is, the non-click nasals are related to the nasal clicks in that they are non-complex versions of the click secondary articulations. Similarly, the ejected click and non-click consonants are related in this way to the non-click [kxʔ], [gkxʔ], and [qʔ], which are non-complex versions of their click counterparts.

The second way in which the non-click and click consonants are related is with regard to which articulator is selected as the major articulator. Thus we have click consonants in which the back articulator is primary and non-click consonants in which the front articulator is primary. This type of relationship is limited to the dentals and post-dentals.

Based on the data in the UPSID sample (Maddieson 1984), we find a general tendency for complex segments to co-occur with their non-complex counterparts. Thus we find a universal tendency for languages which have /$k^{ʔw}$/ to also have /kʔ/ (94.4% of cases), and /k^w/ (88.8% of cases). Similarly, all languages in the sample with /k^w/, and 84% of languages with /kʔ/, also have /k/. Thus we have a very strong implicational hierarchy which can be stated as follows; /$k^{ʔw}$/ → /kʔ/, /k^w/ → /k/. A similar hierarchy holds for uvular stops so that we can formulate an implicational hierarchy such as /$q^{ʔw}$/ → /qʔ/, /q^w/ → /q/. Under the proposed analysis, we find that this tendency is realized in !Xóõ for all the clicks. As shown above, we find that all of the click primary (back) articulations exist in the language as non-click consonants with no additional secondary articulations.

The UPSID sample also shows that there is a weak tendency for /k^w/ to co-occur with /w/. This suggests that there is an implication that consonant secondary articulations will also exist in the language as independent segments. In !Xóõ, as expected, we found that this implication holds, although not quite as strictly as the implication discussed above. Most of the secondary (front) click articulations exist in the language as independent consonants. However, the language has no palatal non-clicks whilst it has the full complement of palatal clicks. Thus, we have seen that with an analysis of clicks in which the back articulation is primary and the front articulation is secondary, the relationship between the clicks and non-clicks follows the expected pattern based on cross-linguistic tendencies.

5. Summary and conclusions

This paper presents arguments in favor of an analysis of clicks in which the back articulator is represented under the primary, C-place node and the front articulator is represented under the secondary, V-place node. This analysis captures generalizations of three kinds. Firstly, as initially observed by Sagey, the front articulation of clicks does not enter into any oppositions based on degree of stricture. Within the theory adopted here, the degree of stricture features of the segment apply to the C-place node and the articulation represented under the V-place node will not contrast for degree of closure. Secondly, it is has been shown that this representation accounts for certain asymmetries between consonant and vowel interactions. Finally, under this analysis, we find that the general consonant inventory of !Xóõ, a typologically unusual language, can be shown to conform to universal tendencies regarding the co-occurrence of complex and plain consonants.

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