18 The Representation of Clicks

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1 Introduction

Click consonants are a type of complex segment. Complex segments are defined as single segments that have two oral constrictions that are nearly simultaneous (Sagey 1990). Click consonants have an anterior constriction, which is either labial or coronal, and a posterior constriction, which is uvular in those Khoesan languages in which posterior place of clicks has been investigated with articulatory methods. The posterior place of clicks in Zulu starts out as velar in the closure, and releases at a uvular place of articulation. Clicks are unique in that they are produced with an ingressive lingual (also known as velaric) airstream mechanism, which is produced by trapping air between a lingual or linguo-labial cavity formed between the two oral constrictions. The tongue moves, in different ways for different clicks, to expand this oral cavity and thus to rarefy, or decompress, the air within it. When the anterior constriction is released, air rushes in to make the characteristic popping sound. The lingual ingressive airstream differentiates clicks from pulmonic stop consonants, which are produced on an outward flow of air from the lungs, and from other complex segments, such as labial-velars and labial-coronals, which are produced using a pulmonic or glottalic airstream.

Clicks have played an important role in phonological theory because of the phonological complexity that they exhibit, and the large number of click contrasts found in Khoesan language inventories. Clicks exhibit at least three major areas of complexity that are not found in most other consonants: (1) the double place of articulation features; (2) the overlap of the two constrictions for the length of the segments; and (3) the non-pulmonic airstream mechanism. In early representations of clicks, the suction used to form the airstream was recognized. However, later proposals capture the two places of articulation features in clicks, and assume that the non-pulmonic airstream is a redundant feature that is predictable from having two simultaneous oral places of articulation. Recent representations incorporate features capturing the unique airstreams involved in clicks.

In order to capture the phonological representation of clicks, there are five major dimensions that must be accounted for. First, there are the four major dimensions used for all stop consonants: place of articulation, manner of articulation (including lateral contrasts), laryngeal setting, and nasality (see CHAPTER 22: CONSONANTAL

Table 18.1 Recognized and unrecognized click types

Click	*Symbol*	*Source*
bilabial	[ʘ]	IPA (2006)
dental	[ǀ]	IPA (2006)
alveolar (N|uu), postalveolar (Ju|'hoansi)	[ǃ]	IPA (2006)
lateral alveolar	[ǁ]	IPA (2006)
palatal	[ǂ]	IPA (2006)
retroflex	[ǃǃ]	Doke (1925), Snyman (1997), Miller *et al.* (2009c)

PLACE OF ARTICULATION, CHAPTER 13: THE STRICTURE FEATURES, CHAPTER 31: LATERAL CONSONANTS, and CHAPTER 29: SECONDARY AND DOUBLE ARTICULATION for more discussion). In addition, clicks involve a non-pulmonic airstream, referred to as velaric (Beach 1938; Ladefoged and Traill 1984, 1994; Ladefoged and Maddieson 1996) or lingual (Miller *et al*. 2007; Miller *et al*. 2009a), which is unique to these consonants. Click languages exhibit a range of inventory sizes, and the languages exhibit a range of complexity on each of these five dimensions.

Place of articulation features for clicks are complicated, because both the anterior and posterior places of articulation must be accounted for, as well as the relative timing of these features. Historically, researchers thought that all clicks had a velar posterior place of articulation (Doke 1923; Beach 1938; Traill 1985; Ladefoged and Maddieson 1996). Thus it was thought that posterior place was not contrastive. Click types are therefore named according to the anterior place of articulation. Recent phonetic and phonological studies have provided evidence that the posterior constrictions of clicks are post-velar, and that some of the clicks involve tongue root retraction.

Six distinct click types have been attested in Khoesan languages. These are provided in Table 18.1. The bilabial click occurs only in the related Tuu languages !Xóõ (Traill 1985) and N|uu (Miller *et al*. 2009a), and in the Ju-ǂHoan language ǂHoan (Bell and Collins 2001).[1] Other languages with a bilabial click, such as |Xam, are now extinct. The retroflex click has been described phonetically by Doke (1925) and Miller *et al*. (2009c) in Grootfontein !Xung. Snyman (1997) provides a survey of !Xung languages, and transcribes the retroflex click in several !Xung-speaking areas surrounding Grootfontein. Heine and König (2010) describe a different click in Ekoka !Xun as retroflex, but phonetic description of this click is lacking. Sands (2007) suggests that it may be a retracted lateral, based on preliminary acoustic analysis of a few tokens. The click corresponds historically to the palatal click in other Ju-ǂHoan languages, and behaves synchronically similarly to the palatal click with respect to the Back Vowel Constraint, described in §4.1.

Language inventories display a wide range of variation in the number and types of clicks. Table 18.2 lists the languages that contain one-, three-, four-, and five-click inventories. The Cushitic language Dahalo and the Bantu languages Rumanyo

[1] Ju-ǂHoan is the name of a language family, Ju|'hoan or Ju|'hoansi the name of a language.

Table 18.2 Number of click types in consonant inventories of languages

One-click inventories	Dahalo, Rumanyo, Southern Sotho, Mbukushu
Two-click inventories	—
Three-click inventories	Hadza, Xhosa, Zulu, Sandawe
Four-click inventories (all coronal clicks)	Ekoka !Xung, G|ui, Ju|'hoansi, Khoekhoe, Khwe, Mangetti Dune !Xung, Naro, Yeyi
Five-click inventories (including the labial click)	ǂHoan, N|uu, !Xóõ
Five-click inventories (all coronal clicks)	Grootfontein !Xung

Mbukushu has only one click type – the dental click.[2] Southern Sotho contains only the alveolar click type. There are no languages exhibiting two click types. The Bantu languages Xhosa and Zulu, and the isolates Hadza and Sandawe, each have three-click inventories, containing the dental, central alveolar, and lateral alveolar click types. Many languages have four-click inventories, containing the four coronal click types recognized by the IPA. These languages contain all languages of the Khoe-Kwadi group, as well as most of the members of the Ju branch of the Ju-ǂHoan family. The Ju-ǂHoan language Ekoka !Xung has four click types, but with the retracted lateral click type in place of the central palatal click type [ǂ].

Most of the languages that have five-click inventories are Tuu languages, but ǂHoan also has five click types. These languages include the four coronal click types recognized by the IPA, as well as the labial click type. However, Grootfontein !Xung has the four coronal click types recognized by the IPA, as well as a retroflex click type, [!!], yielding five coronal click types in all (Miller *et al*. 2009c).

Clicks also occur paralinguistically in many languages throughout the world. For example, a lateral click is used in English to encourage a horse to trot (Ladefoged 1982), and a dental click is used to express disapproval, commonly represented as *tsk-tsk*. Clicks are also used as discourse markers in English (Wright 2007), and have been reported to occur in an auxiliary language of Lardil, Damin, which has bilabial, dental, apico-alveolar, and apico-domal nasal clicks (Dixon 1980; Hale and Nash 1997). Clicks are also found in Chinese nursery rhymes (Nathan 2001). Extremely weak clicks have also been shown to occur in German, when alveolar–velar stop sequences overlap at word boundaries (Fuchs *et al*. 2007).

The phonetic characteristics of the retroflex click and the laterally released palato-alveolar click are still being explored, but Miller *et al*. (2009c) describe the retroflex click as a postalveolar click in Grootfontein !Xung. One of the speakers produced this click with a sub-apical contact, but there was both inter-speaker and intra-speaker variation. Grootfontein !Xung is a centrally located lect. Ju|'hoansi, spoken to the east, has an alveolar click in cognate words, and Mangetti Dune !Xung and other northern lects have a lateral alveolar click in the same words (Miller-Ockhuizen and Sands 1999).

[2] Both Rumanyo and Mbukushu clicks exhibit a lot of variation, and can be realized as dental, alveolar, or lateral alveolar click types.

The manner of articulation of clicks is relatively complex. All clicks involve two complete constrictions, and are thus non-continuants. Clicks contrast in the manner of articulation of their release properties. They can have either a release with a complete constriction or a fricated release, as in pulmonic affricates. Thus clicks can be either stops or affricates. The stop and fricative portions of the releases are mostly uvular, though there are additional release properties that may be epiglottal (Miller 2007). The affricates are also airstream contour segments, and will be discussed with the airstream contrasts in §6. There is clear phonological evidence from positional distribution that all click consonants, including nasal clicks, behave phonologically as obstruents. Thus clicks only occur in initial position of roots in the Ju-ǂHoan, Khoe-Kwadi, and Tuu language families.

Click languages display a large range of variation in terms of the complexity of laryngeal contrasts. Table 18.3 lists the languages according to the number of voice onset time (VOT) contrasts contained in the oral click inventories. Languages of the Ju branch of the Ju-ǂHoan language family, and the Tuu language !Xóõ, display the most complexity on the laryngeal dimension, with four-way VOT contrasts. The voiced aspirated clicks are parallel to the voiced aspirated pulmonic stops in Ju|'hoansi in exhibiting a voiceless interval, which Miller-Ockhuizen (2003) attributes to a larger glottal opening gesture than is found in Hindi voiced aspirates. The Bantu language Mbukushu has a simple two-way VOT contrast. The laryngeal settings are independent from the click mechanism. Eleven out of the 19 languages included in this survey contain a three-way VOT contrast.

The fourth dimension that must be accounted for in clicks is the airstream dimension. Miller *et al*. (2007) and Miller *et al*. (2009a) introduce the term "lingual airstream" to replace the term "velaric airstream." They note that the term "velaric" suggests that this airstream is somehow initiated by the velum or that it involves a velar stop, and provide evidence that the posterior release in clicks is uvular not velar. The term "lingual" reflects the anatomical source of air. The tongue is used to create a low-pressure cavity, the anterior release of which initiates the ingressive flow of air. Sagey (1990) argues that airstream is a matter of phonetic implementation, and does not need to be specified in the phonological representation of clicks. I provide evidence that N|uu contains sounds that differ solely in terms of airstream. There are stops that are produced fully with a lingual airstream mechanism, with the shift from ingressive lingual airstream to pulmonic egressive airstream occurring at the CV boundary between a click and a following vowel. These stops contrast solely with a class of stops that involve a shift from lingual ingressive airstream to a

Table 18.3 A subset of VOT contrasts found in click languages[a]

No voicing contrast	Dahalo, Hadza,[b] Khoekhoe
Two-way VOT contrast	Mbukushu
Three-way VOT contrast	Grootfontein !Xung, G|ui, ǂHoan, Xhosa,[c] Zulu, Khwe, Mangetti Dune !Xung, Naro, N|uu, Sandawe, Yeyi
Four-way VOT contrast	Ekoka !Xung, Ju|'hoansi, !Xóõ

[a] Rumanyo is not included in this table.
[b] Hadza has a three-way VOT contrast in pulmonic consonants, but no voicing or aspiration contrasts in the click inventory.
[c] Ladefoged and Traill (1994) refer to the Xhosa voiced click as murmured.

pulmonic egressive airstream, aligned with the release of the anterior constriction in the click. In these sounds, the posterior constriction is maintained for a considerable interval, and there are two stop bursts, the second one being produced with a pulmonic egressive airstream. This second class of sounds are airstream contour segments, which have a primary airstream feature [lingual] as well as a secondary airstream feature [pulmonic]. As we shall see in §3, many of these airstream contour segments are the ones which Nakagawa (2006) analyzes as clusters containing clicks as the first member and pulmonic obstruents as the second member.

Table 18.4 lists the contrastive manners of articulation and airstreams employed in click languages, and the languages which they occur in. In this table, I provide the transcriptions of clicks with different release properties as single segments, following Beach (1938), Ladefoged and Traill (1984, 1994), Miller-Ockhuizen (2003), Miller *et al*. (2009a), and Miller (2010a). A discussion of the analysis of some of these clicks as clusters is provided in §3. The (post)alveolar click [!] is used to symbolize all click places that occur in the languages listed. Eighteen out of 19 languages with clicks have plain oral clicks. The Cushitic language Dahalo is unique, in that it has nasal clicks without oral clicks. Bennett (2008) claims that nasal clicks

Table 18.4 Airstream and manner contrasts in click languages

Lingual stop [!]	Ekoka !Xung, Grootfontein !Xung, G|ui, Hadza, ǂHoan, Xhosa, Zulu, Ju|'hoansi, Khoekhoe, Kxoe, Mangetti Dune !Xung, Naro, N|uu, Rumanyo, Sandawe, Yeyi, Mbukushu, !Xóõ
Linguo-pulmonic stop [!͡q]	G|ui, ǂHoan, Khwe, N|uu, !Xóõ
Voiced linguo-pulmonic stop [ɢ!]	G|ui, ǂHoan, !Xóõ
Linguo-pulmonic affricate [!͡χ]	Ekoka !Xung, Grootfontein !Xung, G|ui, ǂHoan,[a] Ju|'hoansi, Khoekhoe, Khwe, Mangetti Dune !Xung, Naro, N|uu, Yeyi, !Xóõ
Voiced linguo-pulmonic affricate [g!ᵡ]	Ekoka !Xung, Ju|'hoansi, !Xóõ
Linguo-pulmonic aspirated stop [!͡qʰ]	G|ui, ǂHoan, N|uu, !Xóõ
Voiced aspirated linguo-pulmonic stop [ɢ!ʱ]	!Xóõ
Linguo-glottalic stop [!ʼ]	G|ui,[b] Yeyi
Linguo-glottalic stop [!͡qʼ]	G|ui, ǂHoan, !Xóõ
Linguo-glottalic affricate [!͡χʼ]	ǂHoan,[c] Khwe, Naro, N|uu, Yeyi
Linguo-glottalic affricate [!͡kxʼ]	Ekoka !Xung, Grootfontein !Xung, G|ui,[d] Ju|'hoansi, Mangetti Dune !Xung, !Xóõ
Voiced linguo-glottalic affricate [g!͡kxʼ][e]	Ekoka !Xung, Ju|'hoansi, !Xóõ

[a] Bell and Collins (2001) refer to the click in ǂHoan as a voiceless uvular affricate, and transcribe it as q!χ.
[b] Nakagawa (2006) refers to this click as ejected, which differs from click with a glottal stop release, which he transcribes as [k!ʔ]. I have transcribed the G|ui click, [k!ʔ], as [ᵑ!ˀ], following Miller *et al.* (2009).
[c] Bell and Collins (2001) refer to this click in ǂHoan as an affricated uvular ejective.
[d] Nakagawa (2006) transcribes this click as [!qxʼ].
[e] Miller-Ockhuizen (2003) and Miller (2007) transcribe this click as [g!ˣˀ]. Thus it is a heterorganic affricate.

are less marked than oral clicks, based in part on the existence of a language like Dahalo. The linguo-pulmonic stops are fairly rare, occurring only in five of the languages with clicks. Interestingly, these languages come from the Tuu, Ju-ǂHoan, and Khoe-Kwadi language families, showing that there is no clear genetic unity that can be attributed to languages containing these sounds. Their distribution thus supports Güldemann's (2006) proposal that there was a substrate influence from the extinct language |Xam in Southern Africa.

There are few languages with voiced and aspirated linguo-pulmonic stops, and only !Xóõ and G|ui have the same number of VOT contrasts for the linguo-pulmonic stops as for the lingual stops, with !Xóõ exhibiting a four-way VOT contrast among linguo-pulmonic stops and G|ui displaying a three-way VOT contrast among linguo-pulmonic stops. The linguo-pulmonic affricates are much more common. These occur in 12 out of the 19 languages discussed here, but only four of these 12 languages have voiced affricate counterparts.

There are several types of ejective releases that are found on clicks. These sounds have a lingual airstream in the closure, and a glottalic airstream in the release. G|ui has three linguo-glottalic stops: a plain ejected stop [!′],[3] a stop with an extended posterior constriction [!q′], and a click with an ejected affricate release, [!kx′]. The clicks transcribed [!kx′] and [g!kx′] in Ju|'hoansi are transcribed by Miller-Ockhuizen (2003) and Miller (2007) as having epiglottalized releases, [!$^{\text{H}}$] and [!$^{\text{ʕ}}$]. Nakagawa (2006) transcribes the voiceless consonant of the pair as a cluster containing fully uvular releases, [!] + [qχ′]. Miller *et al*. (2009a) state that they consider the pulmonic affricate [kx′] in N|uu to be heterorganic, although N|uu does not have a click with this type of release. The segment is similar to the release found in the [!kx′] and [g!kx′] clicks in these other languages. N|uu does have a contrast between the glottalic consonants [kx′] and [qx′] (Miller *et al*. 2009a). Interestingly, the clicks [!χ′] and [!kx′] never occur in the same language, but the [!χ′] click in N|uu is phonetically distinct from the [!kχ′] (or [!$^{\text{H}}$]) click in Ju|'hoansi.

A fifth dimension that is relevant to the description of stops is nasality. Click languages display a large variation in the number of nasal clicks that are allowed, and the closure and release properties that they contain. The range of known nasal click contrasts is listed in Table 18.5, along with the languages that contain each of the click closure and release properties. Sixteen out of the 19 languages included in the table have plain nasal clicks. These are clicks that have nasalization during the closure, and in the release. Only two languages contain voiceless nasal clicks. Dahalo is interesting in that it contains only nasal clicks, and no oral clicks, and it contains both voiceless nasal and voiced nasal clicks. The voiceless nasal aspirated clicks, [$^{\text{n̥}}$!$^{\text{h}}$], are more common than the plain voiceless nasal clicks. They occur in eight languages. Four of these languages, all of the Ju branch of the Ju-ǂHoan language family, contain voiced nasal aspirated clicks. Three languages from unrelated families contain preglottalized nasal clicks. Thirteen languages contain the voiceless nasal glottalized click. Khwe is the only language to have a prenasalized voiced click.

The glottalized click is not transcribed with nasality by linguists working on most of the languages in this group, but it is for Hadza (Sands *et al*. 1993) and N|uu (Miller

[3] Nakagawa (2006) claims that there is a contrast between an ejected click and a glottalized click in G|ui, though see (1) for another interpretation of the contrast. In other languages where there is no contrast, clicks transcribed as [!′] are usually voiceless nasal glottalized clicks.

Table 18.5 Types of nasal clicks and languages that they occur in

Voiced nasal click [ᵑ!]	Dahalo,[a] Ekoka !Xung, Grootfontein !Xung, G|ui, Hadza, ǂHoan, Xhosa, Zulu, Ju|'hoansi, Khoekhoe, Khwe, Mangetti Dune !Xung, Naro, N|uu, Sandawe, Yeyi, !Xóõ
Voiceless nasal [ᵑ̊!]	Dahalo,[b] !Xóõ
Voiceless nasal aspirated [ᵑ̊!ʰ]	Ekoka !Xung, Grootfontein !Xung, G|ui, ǂHoan, Ju|'hoansi, Khoekhoe, Mangetti Dune !Xung, N|uu, !Xóõ
Voiced nasal aspirated [ᵑ!ʰ]	Ekoka !Xung, Ju|'hoansi
Preglottalized nasal click [ˀᵑ!]	Ekoka !Xung, ǂHoan, !Xóõ
Voiceless nasal glottalized click [ᵑ̊!ˀ]	Ekoka !Xung, Grootfontein !Xung, G|ui, Hadza, ǂHoan, Ju|'hoansi, Khoekhoe, Khwe, Mangetti Dune !Xung, Naro, N|uu, Sandawe, Yeyi, !Xóõ
Prenasalized voiced click [ᵑ!g]	Khwe
Murmured nasal [ᵑ̈!]	Xhosa[c]

[a] Dahalo also has a nasal labialized click, which Maddieson *et al.* (1993) transcribe as [ŋ|w].
[b] Dahalo also has a voiceless nasal labialized click, which Maddieson *et al.* (1993) transcribe as [ŋ̊|w].
[c] Ladefoged and Traill (1994) note that the murmured nasal click in Xhosa acts as a depressor in lowering the tone on the following vowel.

et al. 2009a). Nasalization has been shown to exist in the release in Khoekhoe (Beach 1938; Ladefoged and Traill 1984) and !Xóõ (Ladefoged and Traill 1984). Ladefoged and Traill (1984: 6) further show that when two words combine, the glottalized clicks are realized with a voiced nasal in Khoekhoe, and thus they propose that the Khoekhoe clicks should be specified as [+nasal] in the phonology. Brugman (2009) shows further evidence of the voicing of these nasals in Khoekhoe, and Miller *et al*. (2007) provide similar data in N|uu. Ladefoged and Traill (1984) consider the nasality associated with this click to be phonetic detail in !Xóõ. Glottalized clicks in Ju|'hoansi co-occur almost exclusively with phonemic nasalized vowels.

Any phonological account of clicks needs to be able to capture all of these contrastive clicks. In the next section, I provide a brief background on the languages that contain clicks, and discuss their geographical and historical relationships to each other. In §3, I compare unit analyses of clicks (Miller *et al*. 2009a; Miller 2010a) with cluster interpretations of clicks (Güldemann 2001; Nakagawa 2006). In addition to contrast, phonological theories need to capture phonological co-occurrence restrictions and positional constraints. For the remainder of the chapter, I discuss phonological evidence for three dimensions of clicks. In §4, I discuss place of articulation features for clicks, focusing on the Back Vowel Constraint, a co-occurrence restriction that rules out combinations of central and lateral alveolar click types with front vowels. In §5, I discuss manner of articulation features for clicks, focusing on a positional distributional constraint which provides evidence that clicks are obstruents and complex segments. In §6, I provide evidence from the existence of airstream contour segments that clicks bear an airstream feature. In §7, I conclude this chapter.

2 Background

Clicks occur primarily in southern African and east African languages in seven language families. The east African click languages, Hadza and Sandawe, are both spoken in Tanzania, and there has thus far been little diachronic evidence to link them genealogically to southern African Khoesan languages, or to each other (Sands 1998), though see Güldemann and Elderkin (2010) for evidence that Sandawe is related to the Khoe-Kwadi language family. Hadza is currently thought to be a language isolates. Dahalo is a Cushitic language with clicks (Maddieson *et al*. 1993) which is spoken in Kenya. Dahalo has thus far not been shown to be related to the geographically closest click languages, Hadza or Sandawe. However, Ten Raa (1969) has suggested that there might be a common substratum between Dahalo and Sandawe.

The majority of click languages are spoken in southern Africa. The non-Bantu southern African click languages were described by Greenberg (1966) as belonging to one language family called Khoisan. They were grouped together as the Northern, Southern, and Eastern Southern African Khoisan branch of the Khoisan family, along with Hadza and Sandawe. The southern African Khoesan languages are currently spoken mainly in Namibia, Botswana, and South Africa, but related languages were historically present in Zimbabwe, Zambia, and Angola, and there are still small pockets of speakers in these countries today (Brenzinger 2001).

Güldemann (2006) argues that the non-Bantu southern African click languages belong to at least three distinct families: the Khoe-Kwadi family, the Ju-ǂHoan family, and the Tuu family. He has demonstrated that similarities in the number of clicks in the inventories of Tuu and Khoe-Kwadi languages can be attributed to a substrate, rather than a genealogical relationship between these languages. I follow Güldemann in using the term "Khoesan" as a neutral way of referring to click languages that do not belong to the well-established Bantu or Cushitic families, with no implied genealogical relationship. I use "Khoesan" rather than"Khoisan" because the spelling matches the orthographies of the languages involved.

In southern Africa, clicks also occur in a number of Bantu languages, most notably southern Bantu languages of the Nguni group, including Zulu and Xhosa. These languages have been shown to have adopted clicks through the process of Hlonipa and regular borrowing (Herbert 1990), but they are now a fully functional part of the language inventories. Clicks also occur in the Namibian Bantu languages Rumanyo (Gciriku), Mbukushu, Mbalan'we, and Fwe (Baumbach 1997) as well as Yeyi, spoken in both Namibia and Botswana (Fulop *et al*. 2003), and Tumbuka, spoken in Malawi.

In this chapter, I focus mainly on phonological patterns found in Khoesan languages, though I also refer to evidence from Zulu. Many of the Khoesan languages are underdocumented and underdescribed. The patterns discussed in this chapter all come from a subset of languages that contain sufficient description of phonological patterns. The languages discussed, and their sources, are listed in Table 18.6.

3 Unit *vs*. cluster analyses of clicks

The presence of clicks in a consonant inventory increases the size of the inventory. However, there is a large range in inventory sizes among the different languages

Table 18.6 Click languages discussed in this chapter and their sources

Language	*Family*	*Source(s) of phonological description*
Dahalo	Cushitic	Maddieson *et al.* (1993)
Ekoka !Xung	Ju-ǂHoan	Heine & König (2010)
Grootfontein !Xung	Ju-ǂHoan	Doke (1925)
G|ui	Khoe-Kwadi	Nakagawa (2006)
Hadza	Isolate	Sands *et al.* (1993)
ǂHoan	Ju-ǂHoan	Bell & Collins (2001)
Ju|'hoansi	Ju-ǂHoan	Snyman (1970, 1975); Miller-Ockhuizen (2003)
Khoekhoe	Khoe-Kwadi	Beach (1938); Brugman (2009)
Khwe	Khoe-Kwadi	Kilian-Hatz (2003)
Mangetti Dune !Xung	Ju-ǂHoan	Miller *et al.* (2008)
Naro	Khoe-Kwadi	Visser (2001)
N|uu	Tuu	Miller *et al.* (2009a); Miller (2010a)
Rumanyo (Gciriku)	Bantu	Mölig & Shiyaka-Mbereme (2005)
Sandawe	Isolate	Wright *et al.* (1995); Hunziker *et al.* (2008)
!Xóõ	Tuu	Traill (1985, 1994)
Xhosa	Bantu	Ladefoged & Traill (1994)
Yeyi	Bantu	Fulop *et al.* (2003)
Zulu	Bantu	Doke (1926); Thomas-Vilakati (2010)

containing clicks. Güldemann (2006) provides inventory size, as well as the proportion of non-clicks to clicks in the inventories of Tuu and Khoe languages, showing a range of inventory sizes within each of these families. The Bantu language Zulu has 45 segments, 12 of which are clicks (Thomas-Vilakati 2010). The Tuu language !Xõó has the largest number of segments that has been documented so far, with a total of 119 contrastive segments, 83 of which are clicks. N|uu has 73 segments, 45 of which are clicks. G|ui is described by Nakagawa (2006: 259) as having 53 segments and a number of clusters involving clicks, but he notes that under a unit analysis it would have 89 segments. Ju|'hoansi has 89 contrastive segments, 47 of which are clicks. ǂHoan has 55 clicks, and Khwe 32.

Traill (1993), Güldemann (2001), and Nakagawa (2006) argue that a click containing a pulmonic release should be represented as a consonant cluster comprised of a sequence of a lingual segment and a pulmonic segment. Güldemann's (2001) and Nakagawa's (2006) arguments for a cluster interpretation of clicks are that the interpretation decreases the size of the consonant inventory, and that under a cluster interpretation all of the second members of the cluster exist as independent segments in the inventory. Further, Güldemann (2001) argues that the simple stop types that are contained in the clusters are more frequent than the cluster types.

Ladefoged and Traill (1984: 11) note that cluster analysis of clicks for !Xóõ would result in clusters of segments that differ in voicing, which was a language type not known to exist at the time.

Miller *et al*. (2009a) argue that not all click release types in N|uu occur as single segments in that language. This is problematic for cluster analyses of clicks, because segments that occur in clusters almost always occur as single segments as well. Further, Miller *et al*. (2009a) argue that if airstream contours are represented as consonant clusters with clicks as their first members, then languages such as G|ui would be the only languages in the world with obstruent–obstruent clusters but not obstruent–sonorant clusters. A survey of cluster types by Kreitman (2008) found no languages with obstruent–obstruent clusters that did not also have obstruent–sonorant clusters. Kreitman's study did find languages with clusters of mixed voicing – most notably Modern Hebrew. I argue that large inventories arise in languages with clicks, because these languages make full use of airstream as a contrastive dimension. Miller-Ockhuizen (2003) shows that pulmonic stop–sonorant clusters that occur in loanwords from English and Afrikaans into Ju|'hoansi are broken up by epenthesis, providing phonological evidence that Ju|'hoansi does not allow stop–sonorant clusters.

(1) lists the inventory of G|ui consonants, including the interpretation of all of the clicks as single units, in the spirit of Miller *et al*. (2009a), and Nakagawa's (2006) interpretation of some of the clicks as clusters. Nakagawa's analysis transcribes a distinction between "velar" clicks and "uvular" clicks, and transcribes all clicks with either a "k" or a "q," following Ladefoged and Maddieson (1996). Miller *et al*. (2009a) and Miller (2010a) have shown, using ultrasound imaging of the tongue during click production in N|uu, that the posterior release of [ǂ] and [ǂ͡q], on the one hand, and [!] and [!͡q], on the other, occurs at the same location, and that in all four clicks the location is uvular. In [ǂ] and [ǂ͡q], the posterior release location is back uvular and does not involve tongue-root retraction, while in [!] and [!͡q], the posterior release location is front uvular and involves a ballistic tongue-root retraction movement. Miller *et al*. (2009a) argue that the glottal stop in N|uu is allophonic in vowel-initial words, and thus does not occur as a single segment in the language. Furthermore, the glottal fricative in N|uu and most Khoesan languages is voiced, and thus does not correspond to the voiceless aspiration found in the voiceless nasal aspirated click.

(1)

a.	*Unit analysis*	*Cluster analysis*	b.	*Unit analysis*	*Cluster analysis*
	!	/k!/		!$^{\chi}$	/k!/ + /χ/
	^{g}!	/g!/		!$^{k\chi'}$ or !^{H}	/k!/ + /qχ′/[4]
	^{ŋ}!	/ŋ!/		!q	/k!/ + /q/
	!^{h}	/k!^{h}/		ɢ!	/k!/ + /ɢ/
	!^{ʔ}	/k!′/		!q^{h}	/k!/ + /q^{h}/
				!q′	/k!/ + /q′/
				$^{ŋ̊}$!^{ʔ}	/k!/ + /ʔ/
				$^{ŋ̊}$!^{h}	/k!/ + /h/

[4] Nakagawa notes that this click and the similar pulmonic consonant [qχ′] are both realized with a lateral release. However, he notes that this click does not spread the lateral feature to a medial consonant the way that lateral clicks do. He thus claims that the lateral release is phonetic detail.

A third piece of evidence that Nakagawa claims points to a cluster analysis is the synchronic correspondence between clicks and non-clicks that can be seen in comparing G|ui with the closely related dialect G‖ana. Nakagawa provides cognate pairs such as G|ui /k!áā/ and G‖ana /káā/ 'miss', and G|ui /k!qárā/ and G‖ana /qárā/ 'break', which he attributes to a diachronic process of click change. I view the diachronic phonology as independent from the synchronic phonology (see CHAPTER 93: SOUND CHANGE).

The first five clicks in (1a) are not clusters under Nakagawa's analysis (though they would be under Güldemann's 2001 radical cluster analysis). Thus, Nakagawa (2006: 205) provides the rule in (2) to account for the change from clicks to pulmonic consonants (1a).

(2) /k!/ + /C<offset>/ → /C<offset>/

Nakagawa (2006) proposes the constraint in (3) to account for the types of clusters allowed in G|ui. The feature [coronal] is meant to target the pulmonic stops /t ts c/ and the four clicks /k| k! k‖ k‡/, while the offsets contain the following list of consonants: [q ɢ q^h q' qχ' χ ʔ h]. The constraint thus allows the consonants [tχ tsχ tqχ' tsqχ'], as well as the complex click consonants listed in (1).

(3)	C<onset>	C<offset>
	[coronal plain stop]	[uvular or glottal]

A comparison of Nakagawa's cluster analysis and Güldemann's (2001) radical cluster analysis, which interprets all clicks as clusters, is provided in Nakagawa (2006). Güldemann (2001) analyzes more clicks as clusters, which results in much smaller click inventories. The unit *vs*. cluster interpretation of complex clicks and complex pulmonic consonants lies at the center of the representation of clicks. Throughout the remainder of this chapter, I will describe the phonological patterns in click languages that provide evidence for three dimensions of clicks (place, manner, and airstream) in a neutral way, and then discuss both unit and cluster analyses where they are available.

4 Phonological evidence for place of articulation in clicks

There are two sources of evidence for the place of articulation of clicks. The first source of evidence is the Back Vowel Constraint (BVC), a co-occurrence constraint which occurs in many Khoesan languages. This constraint rules out the co-occurrence of clicks with posterior constrictions involving tongue-root retraction and uvular consonants with following front vowels. The BVC has been described in the Tuu languages !Xóõ (Traill 1985) and N|uu (Miller 2010a), the Ju-ǂHoan language Ju|'hoansi (Miller-Ockhuizen 2000, 2003) and the Khoe-Kwadi language G|ui (Nakagawa 2006). A second source of evidence is a process of nasal assimilation, whereby nasals assimilate to the posterior place of articulation of clicks in Zulu (Doke 1926; Maddieson and Ladefoged 1989). I discuss the Back Vowel Constraint first, and then move on to the discussion of nasal assimilation.

4.1 The Back Vowel Constraint

The Back Vowel Constraint is a CV co-occurrence restriction that blocks the co-occurrence of front vowels with a class of consonants, including labial and alveolar clicks (see also CHAPTER 75: CONSONANT–VOWEL PLACE FEATURE INTERACTIONS). In this section, I discuss the BVC patterns in G|ui (Nakagawa 2006), Ju|'hoansi (Miller-Ockhuizen 2003), N|uu (Miller 2010a), and !Xóõ (Traill 1985; Sagey 1990), and provide different analyses of the BVC. Most authors (Traill 1985; Sagey 1990; Clements and Hume 1995; Miller 2010a) analyze the BVC as assimilation between the posterior place of articulation of clicks and following front vowels. Earlier analyses viewed the posterior constrictions in clicks as velar, based on early phonetic studies. Miller (2010a) views the posterior constrictions of clicks as uvular, based on her ultrasound investigations of the posterior constrictions in clicks (Miller *et al*. 2007; Miller *et al*. 2009a; Miller 2010a), and she states the BVC as assimilation to an [RTR] feature of clicks. Nakagawa (2006) analyzes the BVC as assimilation between the anterior tongue shape of clicks and following front vowels. Miller's (2010a) and Nakagawa's (2006) analyses capture different patterns of linguopulmonic contour segments (Miller *et al*. 2009a) in N|uu and the phonetically similar clicks that are analyzed as clusters of clicks followed by uvular pulmonic segments in G|ui. The two analyses also make different predictions about the patterns found with non-click consonants, particularly labials.

Previous phonetic literature has described the posterior constriction in all clicks as velar (Doke 1923; Beach 1938; Ladefoged and Traill 1984, 1994; Traill 1985; Ladefoged and Maddieson 1996), and phonological representations of clicks have captured the posterior constriction with the phonological feature [+back] (Chomsky and Halle 1968; Sagey 1990) or the feature [dorsal] (Traill 1993; Clements and Hume 1995). The initial description of the BVC (Traill 1985) in !Xóõ treats all clicks, as well as velar stops, as being subject to the constraint. The BVC, stated in (4), changes a front vowel to a [+back] vowel by assimilation to the [+back] feature of the click.

(4) *Back Vowel Constraint* (Traill 1985)

if:	C_1	V_1
	<+back>	
then:	C_1	V_1
	<+back>	<+back>

A second process, Dental Assimilation, changes back vowels following dental [|] and palatal [ǂ] clicks to front vowels, in effect undoing the BVC. Chomsky and Halle (1968) and Sagey (1990) use the feature [+anterior] to classify the dental and palatal clicks separately from the central and lateral alveolar clicks. The Dental Assimilation rule in Sagey (1990) crucially requires palatal clicks to be [+anterior], in keeping with the fact that the palatal click has a long laminal constriction stretching from the dental place of articulation to the post-alveolar place of articulation (see Sands *et al*. 2007 and references therein).

Miller-Ockhuizen (2003) argues that there are two classes of clicks: those that are subject to the BVC, and those that are not. She proposes that the central alveolar [!] and lateral alveolar [ǁ] clicks that are subject to the BVC have a uvular

posterior constriction, which is specified for a [pharyngeal] feature. She proposes the BVC in (5), using Clements and Hume's (1995) feature theory (see CHAPTER 27: THE ORGANIZATION OF FEATURES):

(5) *Back Vowel Constraint* (Miller-Ockhuizen 2003)

*{[pharyngeal]$_{Vplace}$ [coronal]$_{Vplace}$ }$_{\sigma}$

[pharyngeal] and [coronal] cannot be specified on the same or different V-place within a syllable.

She argues that front vowels are underlyingly present in Ju|'hoansi following dental and palatal click types, and dental and palatal clicks are unspecified for the feature [pharyngeal].

Traill (1997) proposes the acoustic feature [+grave] to account for BVC patterns in !Xóõ, which also contains the labial click. His analysis captures the fact that labial and alveolar clicks pattern together with respect to the BVC. However, Miller-Ockhuizen (2000) shows that pulmonic labial consonants and labial clicks pattern differently in !Xóõ, and thus this feature is problematic. Traill (1985) considered initial labial consonants to be only found in loanwords in !Xóõ. Labial consonants are low frequency in root-initial position, but extremely frequent in root-medial position in most Khoesan languages (see Miller-Ockhuizen 2003: 131 for Ju|'hoansi and Miller (2010a) for N|uu).

Miller (2010a) provides the results of a database study over the N|uu lexicon. The phonological patterning of N|uu consonants with respect to the BVC is summarized in Table 18.7. Miller (2010a) analyzes the BVC as assimilation of a front vowel to an [RTR] feature on the consonant.

Table 18.7 Patterning of N|uu consonants with respect to the BVC

	Occur with front and back vowels	*Occur with back vowels and the* [əi] *and* [æ] *allophones of* /i/ *and* /e/
Pulmonic stops	Labial [b β] Alveolar [s z ɾ] Palatal [c ɟ ʃ ʒ] Velar [k g]	Uvular [q ɣ kχ′]
Clicks	Dental click [ǀ] Palatal click [ǂ]	Labial click [ʘ] Central alveolar click [ǃ] Lateral alveolar click [ǁ]
Clicks with airstream contours (stops)	Dental clicks [ǀ͡q] Palatal clicks [ǂ͡q]	Labial click [ʘ͡q] Central alveolar click [ǃ͡q] Lateral alveolar click [ǁ͡q]
Clicks with airstream contours (affricates)		Uvularized labial click [ʘ͡χ] Uvularized dental click [ǀ͡χ] Uvularized central alveolar click [ǃ͡χ] Uvularized lateral alveolar click [ǁ͡χ] Uvularized palatal click [ǂ͡χ]

The patterning of dental and palatal linguo-pulmonic stops, [|͡q] and [ǂ͡q], in N|uu provides evidence that these clicks are unspecified for [RTR] (see CHAPTER 25: PHARYNGEALS). Herzallah (1990), Elorietta (1991), McCarthy (1994), and Rose (1996) have shown that both uvulars and pharyngeals cause retraction of front vowels in Semitic languages. Uvular and pharyngeal sounds are thus generally characterized as all being specified for the feature [RTR]. The N|uu click patterns suggest that there are uvular constrictions that don't involve the feature [RTR]. Phonetically, the posterior place of articulation in N|uu palatal clicks is back uvular, at the point where the oral tract and pharynx meet, and it does not involve tongue-root retraction (Miller *et al*. 2009a; Miller 2010a). The posterior constriction in dental and palatal clicks is more like the production of [u] (Miller *et al*. 2009b), which involves tongue-root raising (Esling 2005), not tongue-root retraction. Miller (2010a) notes that these differences in articulation are consistent with their differences in featural specification. The alveolar click is specified for the feature [RTR], while the palatal click is unspecified for the feature.

Nakagawa (2006) describes the patterning of G|ui consonants with respect to the BVC. The patterns seen in G|ui largely mirror those found in N|uu, except that the click clusters with uvular offsets, [|q !q ‖q ǂq] (Miller *et al*.'s 2009a linguo-pulmonic stops), are all subject to the BVC in this language. Nakagawa accounts for the BVC in G|ui using the two constraints in (6). One constraint accounts for the click patterns, and the other for the non-click patterns. Nakagawa notes that Cq represents a non-click uvular consonant, i.e. /q ɢ qʰ q′ qχ′ χ/, whether it occurs as an independent consonant or as a cluster offset, and "!/‖" stands for an apical click. The alveolar clicks would thus be captured with his feature [+apical], and the uvulars would be captured with the feature [+grave], though this would predict that velar and labial pulmonic consonants are also subject to the constraint. However, Nakagawa (2006: 229) notes that there are 17 words in G|ui that have a velar consonant followed by a [–back] vowel. Nakagawa attributes the presence of front vowels following some velars to the phonetic ambiguity of velars.

(6) a. *Cq V[–back]
b. *!/‖ V[–back]

Miller-Ockhuizen (2003) notes that the velar stops [k] and the velar fricative "x" (Snyman 1970, 1975; Dickens 1994) pattern differently in Ju|'hoansi, and she re-analyzes the fricative as uvular [χ] and the velarized clicks [|x !x ‖x ǂx] as uvularized clicks [|ˠ !ˠ ‖ˠ ǂˠ], based on the raised F1 values in vowels following these sounds. The place difference accounts for the different BVC patterns, as the uvular fricative and the uvularized clicks are [RTR]. This same disparity in [k] and "x" is found in G|ui (Nakagawa 2006: 231), although Nakagawa maintains the traditional description of the dorsal fricative as "velar" and the [|x !x ‖x ǂx] clicks as velarized. As a result, he describes velars as patterning ambiguously. The velar stop [k] in !Xóõ is phonologically ambiguous (Traill 1985). There are both forms with the [əi] allophone of /i/, as in *kai* 'grow', and the [e] allophone of [e] as in the word *kèhn* 'being' in Traill's (1994) dictionary. Further, Traill (1985) notes that the concordially determined forms *ki* (class 1) and *ke* (class 3) are often realized in speech as [ti] and [te], due to the BVC, and Afrikaans loanwords containing [k] are realized with [t] in !Xóõ. The dorsal fricative "x" occurs only with

the [əi] allophone of /i/ in the word *xái* 'to grind' in Traill (1994). Thus, the dorsal stop and fricative appear to pattern differently in all three languages.

The patterning of dental and palatal linguo-pulmonic stops in N|uu, and similar clicks in G|ui, which Nakagawa (2006) analyzes as clusters, is different. The patterning of linguo-pulmonic stops (Traill's "uvular" clicks) in !Xóõ are ambiguous based on the data in Traill's (1994) dictionary. The low frequency of this word type makes it difficult to gauge, but there appear to be words with both [i] as in *|qhíi* 'walk (PL)' and [e] as in *|qáe* [|qée] 'a Nama person', as well as words with [əi], as in the word ǂ*qái* 'species of bird'.

It is not surprising that the BVC can be stated in terms of both anterior tongue shape (Nakagawa's [+apical]) and posterior tongue shape (Miller's [+RTR]). In fact, posterior tongue shape is probably phonetically predictable from anterior tongue shape. The BVC does not occur as a phonological constraint in Khoekhoe (Miller *et al*. 2007; Brugman 2009). Similarly, it does not occur in the Bantu languages containing clicks. The BVC has not been documented in the remaining Khoesan languages. In many of the languages there is not a sufficiently large dictionary available to document the patterns. In the next section, I provide evidence for place of articulation features in clicks based on nasal assimilation patterns.

4.2 Nasal assimilation

The Southern Bantu language Zulu has a productive nasal assimilation process that occurs when the noun class prefix *izi*N- abuts an adjacent stop. Data is provided in (7) from Maddieson and Ladefoged (1989: 135), with the click symbols transliterated from the IPA (1949) symbols to the IPA (1989) symbols. The data show that the nasal of the prefix assimilates to the posterior closure of the clicks, and is realized as a velar nasal when it precedes all three clicks and the velar stop [g] in Zulu.

(7) *Nasal place assimilation in Zulu with the noun class prefix* iziN-

singular		*plural*
u-phaphe	'feather'	izim-paphɛ
u-tʰi	'stick'	izin-ti
u-gu	'river bank'	iziŋ-gu
u-|ʰuʃɛla	'sharp instrument'	iziŋ-|uʃɛla
u-!ʰududu	'tall, careless person'	iziŋ-!ʰududu
u-‖ʰuʃɛla	'sharp instrument'	iziŋ-‖ʰuʃɛla

These data provide evidence that the posterior place of articulation in clicks in Zulu is velar. This is in keeping with electropalatographic data from Zulu (Thomas-Vilakati 2010).

Traill (1985: 122) notes that there is a process of nasal assimilation in !Xóõ, whereby the 1st person singular pronoun /ń-/ and the verbal formative /-ń-/ assimilate to the anterior place of articulation of clicks. However, he does not provide any data.

In the next section, I discuss the distribution of clicks within words. These data provide evidence that clicks are obstruents, and that they are unique as complex segments.

5 The distribution of segments in Khoesan languages

While all previous representations of clicks have classified these segments as [–continuant], no phonological evidence was provided for their status as obstruents. In this section, I review evidence that clicks are classified as obstruents in G|ui, Ju|'hoansi, Khoekhoe, and N|uu. I show that obstruents and sonorants are in complementary distribution in various Khoesan languages, but that the distribution of clicks is restricted more than obstruents, due to their status as complex segments. Furthermore, guttural release properties on obstruents are restricted to initial position. These distributional constraints are similar to those responsible for English flapping and Spanish spirantization. The difference is that click languages have larger inventories (Miller 2010b).

It has been noted since Doke (1925) and Greenberg (1966) that clicks only occur in word-initial position in Khoesan languages. Miller-Ockhuizen (2003) argued that this provided evidence that clicks are obstruents in Ju|'hoansi, since there is a complementary distribution of obstruents and sonorants in the language. Miller-Ockhuizen (2003) and Miller (2010b) shows that the most frequent Ju|'hoansi medial consonants are all sonorants: [m n ŋ β ɾ ɣ], and that 96 percent of root-medial consonants are these sonorants. Conversely, in initial position, 98 percent of roots begin with an obstruent. Further, she shows that stops in loanwords longer than the maximally two-syllable Ju|'hoansi prosodic word are realized as obstruents when they are realized in prosodic word-initial position, and as sonorants in prosodic word-medial position. Further, the break-up of three-syllable Afrikaans or English source words into two prosodic words occurs so as to maximally place obstruents at the beginning of prosodic words, and sonorants in medial position. Miller-Ockhuizen (2003: 127) and Miller (2010b) provide the alignment constraint in (8) to account for these patterns, following McCarthy and Prince (1993).

(8) ALIGN(obstruent, L; PrWd, L)

> The left edge of every obstruent corresponds to the left edge of some prosodic word.

This constraint captures the distributional facts with respect to the sonorant/obstruent distinction, as long as clicks, sibilant fricatives, and guttural fricatives are obstruents, while non-sibilant, non-guttural fricatives are sonorants.

Brugman (2009: 105) shows that we must distinguish between three different positions (root-initial, clitic-initial, and root-medial) in order to capture the distribution of Khoekhoe segments. The distribution in Khoekhoe is provided in Table 18.8, taken from Brugman's table 4.4. Brugman shows that there is a three-way distribution of consonants according to manner of articulation, and that an additional constraint is needed to account for the distribution of clicks, above and beyond the distribution of manner contrasts.

The distribution of clicks is not wholly accounted for by the distribution of obstruents, as there are further constraints on the distribution of clicks in particles. Brugman shows that both positional faithfulness and positional augmentation are needed to capture the distribution. Brugman (2009) follows Smith (2000, 2002) in using a universal sonority-based onset markedness hierarchy, seen in (9) (see also CHAPTER 49: SONORITY):

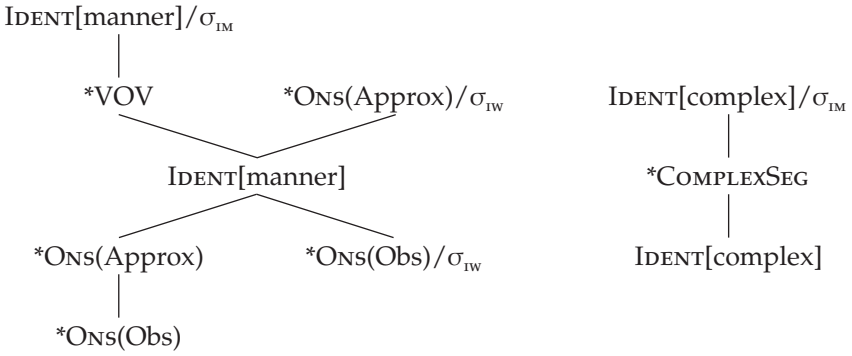
Table 18.8 Distribution of segments in Khoekhoe (Brugman 2009)

Segment	*Root-initial*	*Clitic-initial*	*Root-medial*
[ǀ ǀˣ ᵑǀ ᵑ̊ǀʰ ᵑ̊ǀˀ] [ǃ ǃˣ ᵑǃ ᵑ̊ǃʰ ᵑ̊ǃˀ] [ǁ ǁˣ ᵑǁ ᵑ̊ǁʰ ᵑ̊ǁˀ] [ǂ ǂˣ ᵑǂ ᵑ̊ǂʰ ᵑ̊ǂˀ]	✓		
[p t k ʔ] [ts kx] [s x h]	✓	✓	(p)
[m n]	✓	✓	✓
[ɾ]		✓	✓
[β]			✓

(9) *Ons(Approximant) >> *Ons(Nasal) >> *Ons(Obstruent)

These constraints are ranked with Ident[manner] constraints, and the constraints are relativized to different positions. In order to capture the unique positioning of clicks, she uses the constraint *ComplexSeg. The complete ranking of constraints that accounts for the Khoekhoe patterns is provided in (10), where "iw" is "initial" and "im" is "medial."

(10) *Constraint ranking for Khoekhoe segment distribution* (Brugman 2009)



Additional evidence for *ComplexSeg comes from the distribution of clicks in three different forms of pronouns found in N|uu. Table 18.9 provides a list of three forms of all of the pronouns found in N|uu, which Collins and Namaseb (2007) describe as the simple form, the click form, and the "a" form.

The distribution of these forms of pronouns is syntactically determined (Collins and Namaseb 2007). The simple forms occur in subject position (for non-questions), object position, and possessor position. Collins and Namaseb note that they are not syntactically weak in the traditional sense, since they can appear in coordinate structures, can be modified by numerals and "only," and can be clefted. The click forms of the pronouns appear obligatorily as the subject in yes–no questions

Table 18.9 Simple, click, and a-forms of pronouns in N|uu (Collins and Namaseb 2007)[a]

Simple	*Click*	*a-form*	*Person and number*
ʔń	ŋǀŋ̀	n-á	1st singular
ʔá	gǀà	ʔ-á	2nd singular
kú		kú-a	3rd singular (human)
kí		kí-a	3rd singular (non-human)
hă		hă	3rd singular (anaphoric)
sí ~ʔí	gǀì	s-á cá [kí-a]	1st plural
ʔú	gǀù	b-á [u-á]	2nd plural
kín		kín-a	3rd plural (subject)
kíkē		kík-ā	3rd plural (object)
hǹ		hǹ-a	3rd plural (anaphoric)

[a] The indefinite pronouns contain clicks, which Collins and Namaseb (2007) list as the weak (ǂí), and a-forms (ǂá) of the pronominal system.

and following the linker. The a-form of the simple pronouns appears as the subject of declarative clauses, and also as the first object of a double object construction. The distribution of pronouns can be captured by the relative ranking of *ComplexSeg and Ident[ComplexSeg] in different syntactic positions. However, more syntactic research is needed to define the type of phrase that is active in N|uu phonology.

The Khoesan language !Xóõ has a much larger consonant inventory than Khoekhoe. It contains clicks that have a much richer set of guttural release properties. Brugman (2009) provides distribution of segments in !Xóõ, based on Traill (1979). This is provided in Table 18.10. Clicks and ejectives are licensed only in root-initial position, as well as obstruents with guttural release properties. These data show that *ComplexSeg is not sufficient to capture the distribution of segments in !Xóõ and other Khoesan languages.

The additional constraint that is needed in order to handle the distribution of the ejectives, uvularized segments, aspirates, and the guttural segments [q ʔ x h] is *Guttural, which is defined in (11) below, in terms of the feature [spectral slope] (Miller-Ockhuizen 2003). The spectral slope feature is independently motivated in the Guttural OCP constraint of Juǀ'hoansi (Miller-Ockhuizen 2003: 143).

(11) *Guttural

Segments should not bear [spectral slope] features.

The definition of the [spectral slope] feature is provided in Miller-Ockhuizen (2003: 117) in terms of acoustic voice-quality cues. The gutturals are specified for the feature [pharyngeal] and [spectral slope], as in Table 18.11.

Table 18.10 !Xóõ onsets in different morpho-prosodic positions (Brugman 2009)

Segment	*Root-initial*	*Clitic-initial*	*Root-medial*
clicks	✓		
[tʼ t^{x} d^{x} $t^{xʼ}$ $d^{xʼ}$]	✓		
[tsʼ dzʼ ts^{x} dz^{x} $ts^{xʼ}$ $dz^{xʼ}$]			
[ʔm ʔn]	✓		
[t^{h} ts^{h} d d^{h} dz dz^{h}]	✓		
[q ʔ ts f x h]	✓		
[p t k s]	✓	✓	
[m n]	✓	(n)	✓
[l]		✓	✓
[β j ɲ]			✓

Table 18.11 Featural specification of guttural consonants and vowels

Value for [pharyngeal]	[pharyngeal]		*Unmarked for* [pharyngeal]	
[spectral slope] *value*	[high]	[low]	[high]	[low]
aspirated consonants/breathy vowels			✓	
glottalized consonants/glottalized vowels				✓
uvularized consonants	✓			
epiglottalized consonants/epiglottalized vowels		✓		

A constraint, ALIGN([spectral slope]$_{V}$, L; μ_{1}, L), is proposed by Miller-Ockhuizen (2003: 138) to account for the distribution of guttural vowels within the first syllable of a root. Given the recent advances in positional augmentation, we can capture the distribution of both guttural consonants and vowels in the first syllable of a root by ranking the constraint *GUTTURAL below IDENT[Guttural]/σ_{IW}, and above IDENT[Guttural].

G|ui limits the medial consonants to the set of /b w r j m n/ (Nakagawa 2006: 114), and allows the full set of 89 consonants (or 53 segments plus all possible clusters) initially. Thus, G|ui seems also to have a constraint licensing obstruents in initial position, and sonorants in medial position, just like the other Khoesan languages. However, Nakagawa (2006) reports monomoraic non-root words that contain clicks in G|ui. It is possible that these words may have the same prosodic status as roots, similar to the post-positions and complementizers in Khoekhoe (Brugman 2009: 202). It is also possible that the constraints are ranked differently in G|ui. Clicks are limited to root-initial position in all of the other documented Ju-ǂHoan, Khoe-Kwadi, and Tuu languages, though their distribution in non-roots is unexplored.

In this section, I have shown that there is evidence from a number of Khoesan languages that clicks are phonologically obstruents. Further, I have shown that the marked status of clicks above other obstruents derives from their status as complex segments. The distribution of guttural consonants only in word-initial position in Ju|'hoansi and !Xóõ is accounted for by the markedness of gutturals. The distribution of clicks must be accounted for by any theory of clicks.

6 Airstream contour segments

The existence of contour segments on the airstream dimension in N|uu provides evidence for airstream being an independent dimension of sound structure. These are sounds that differ from lingual clicks only in terms of airstream, and not in terms of place of articulation or manner of articulation (Miller *et al*. 2009a). N|uu (near-)minimal pairs in terms of airstream are provided in (12):

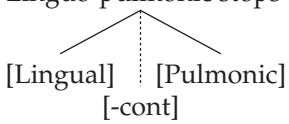
(12) *Minimal pairs in terms of airstream in N|uu*

!ɑɑ	'hartebeest'	!q͡ɑ̃ɑ̃	'strap'
!əi	'run'	!q͡əi	'lead'
!əo	'stone'	!q͡əo	'pluck'
|ũũ	'boil'	|q͡uu	'tobacco'
‖oe	'round rock used to grind tsama pips'	‖q͡oe	'pan (geographical feature)'
ǂoɑ	'sleeping hide'	ǂq͡oɑ	'pot'

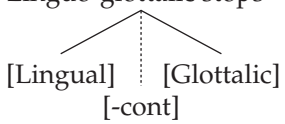
The representation of N|uu airstream contour segments is provided in (13):

(13) *Representation of airstream contour segments*

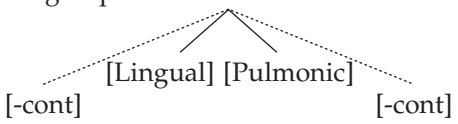
a. Linguo-pulmonic stops



b. Linguo-glottalic stops



c. Linguo-pulmonic affricates



The airstream feature [lingual] has predecessors in Chomsky and Halle's (1968) feature [suction], Ladefoged's (1982, 1997, 2007) feature [click], Güldemann's (2001) feature [ingressive], and Nakagawa's (2006) feature [+enhanced], although these proposals differ in the phonetic content of the feature.

Maddieson and Ladefoged (1989: 135) provide minimal pairs in the Tuu language !Xóõ which they describe as supporting a contrast between velar and uvular clicks in that language. Miller *et al*. (2009a) suggest that these clicks in !Xóõ and G|ui may be ultimately re-analyzed as involving an airstream contrast similar to those in N|uu, but evidence has not yet been gathered to support such

a re-analysis in either of these languages. The diachronic evidence from click change provided in §3 suggests that, at least historically, these segments may have also differed in posterior place phonologically. Without further phonetic studies, we do not know if these clicks may also differ, or have differed in the past, in speakers' productions or in listeners' perceptions. Any theory that accounts for clicks needs to account for airstream contour segments in N|uu.

7 Conclusion

I have provided an overview of the types of evidence that are available for place of articulation, manner of articulation, and airstream of clicks. I have given an overview of unit analysis and cluster analysis of click consonants. I have noted that the unit analysis of clicks results in larger click inventories. Cluster analyses of clicks, on the other hand, result in smaller segment inventories. This comes at a cost, as it results in Khoesan languages being the only languages in the world that allow obstruent–obstruent clusters without also allowing obstruent–sonorant clusters.

There are three main sources of evidence for the phonology of clicks. The Back Vowel Constraint and nasal assimilation provide evidence as to the place of articulation in clicks. The positional distribution of clicks provides evidence that clicks are obstruents, and that their status as complex segments makes them more marked. The existence of airstream contour segments in N|uu provides evidence that airstream is an independent dimension of sound structure. All of these types of evidence must be accounted for by any phonological theory that accounts for clicks.

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