Pulmonic venting and the typology of click nasality*

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Abstract
A cross-linguistic survey of several dozen languages with clicks reveals an unexpected generalization: every language with clicks has nasal clicks. Moreover, some languages have only nasal clicks, and others require clicks to be nasal in certain contexts. Taken together, these point to an implicational universal: oral clicks imply nasal clicks. The explanation offered here is that nasal clicks are not truly [+nasal]; rather, they are clicks with a pulmonic airstream, which can be maintained only by venting excess pulmonic airflow through the nasal cavity. Given this assumption, the observed typology of oral and nasal click distribution can be derived from the relative markedness of non-pulmonic segments more generally, using a simple set of OT constraints.

1. Introduction

1.1 A curious universal of click nasality

In most languages that use clicks as consonants, nasality plays a contrastive role. Some examples are given in (1).[1] The Zulu examples in (1a) illustrate a contrast between voiced oral clicks and voiced nasal clicks, across three different types of clicks (distinguished by the place of the front constriction). The !Xóõ forms in (1b) illustrate nasality distinctions cutting across three laryngeal configurations within a single click type (palatal). Oral ~ nasal contrasts are found with voiceless clicks, with aspirated clicks, and with voiced clicks.

(1) Examples of nasality distinctions in clicks

a. Zulu (Doke 1926)

	Oral	Nasal
Dental	g|aja ‘cover the breasts’	n|aja ‘cloud over’
Alveolar	g!aɓa ‘mark the face’	n!aɓa ‘forbid’
Lateral	g‖an‖a ‘mix milk’	n‖an‖a ‘coax’

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[1] The transcription convention used here and throughout is to use the plain click symbols [ʘ | ǁ ! ǂ] for plain voiceless oral clicks, with preceding [g] marking voicing, and [n] marking nasality, supplemented by normal IPA diacritics to make further distinctions as needed.

b. !Xóõ (Ladefoged & Traill 1994:49)

	Oral	Nasal
Voiceless	ǂàã 'bone'	n̥ǂûʔã 'be out of reach'
Aspirated	ǂʰàa 'stamp flat'	n̥ǂʰàã 'ahead'
Voiced	gǂàa 'exploit'	nǂàa 'peer into'

The nasality of the nasal clicks in (1) is generally taken at face value: these clicks are presumed to be phonologically [+nasal], or some equivalent thereof (Trubetzkoy 1939, Chomsky & Halle 1968, Sagey 1990, Miller et al. 2009, Miller 2011; see also Güldemann 2001, Nakagawa 2006, Naumann 2008, Brugman 2009, etc.). This null hypothesis makes a good deal phonetic sense: higher-than-normal nasal airflow is to be expected from segments that are [+nasal] – they sound like nasals normally ought to. It also makes phonological sense, in that a [±nasal] feature is well motivated and useful for understanding non-clicks – the representational apparatus is already in hand.

What calls this simple explanation into question is a curious universal, summarized in (2): oral clicks imply nasal clicks. The basis for this claim is a survey of clicks in approximately 45 languages, presented in further detail in section 2. This implicational universal holds over inventories of clicks in languages that have them: all languages with oral clicks have nasal clicks, but not vice versa. The universal also holds over the distributions of clicks in languages that make an oral ~ nasal contrast: nasal clicks may occur wherever oral clicks are found, but not vice versa.

(2) Universal implication: **! → n!**
   a. If a language allows oral clicks, then it also allows nasal clicks.
   b. If oral clicks are allowed in a given morpho-prosodic position, then nasal clicks are also allowed in that position.

1.2 The puzzle

The implicational universal in (2) is surprising because nasals don't otherwise work this way. If anything, non-click segments show a trend in the opposite direction: nasal normally implies oral (cf. Trubetzkoy 1939). All languages with nasal vowels also have non-nasal ones (Comrie 1989, etc.). Some languages are claimed to lack (contrastively) nasal consonants (Cohn 1993)[2]; no languages are claimed have nasals, but no oral consonants. Nasalized continuants and sonorants also imply oral ones: few languages allow nasalized [s̃], but all those that do all also have oral [s], and nasalized [l̃] likewise implies non-nasal [l] (Cohn 1993, Walker 1998). It has also been claimed that nasals never make more place of articulation contrasts than stops (Ferguson 1975). Even if some of these claims have counter-examples, the net impression they convey is that nasal segments are more restricted than oral ones – the opposite of the pattern found with clicks.

Perhaps nasality behaves in a strange way for clicks because clicks are simply strange. After all, they are phonetically more complex than many other segments. As sounds, they are both common and salient, and paralinguistic usage of clicks for turn-taking or other purposes is so widespread as to possibly verge on universal (Wright

[2] Such languages include Hakka, Mura, Pawnee, Rotokas, and various Salishan languages; see Cohn (1993) for further details.

2011, Gil 2013). But as segments, they are vanishingly rare, attested as normal segments in only a small number of languages, most of which are related by contact and/or genealogy. Additionally, many of the languages that do have clicks have them in superabundance. Xhosa, for example, has 15 clicks (Sands 1991) – a number that seems large when we note that the median consonant inventory according to WALS is only 21 (Maddieson 2013). And other languages have far more clicks: Jun|'hoan has 36, and !Xóõ has 80 – more clicks than most languages have segments.

If clicks are unusual in so many various and sundry ways, perhaps it's not surprising that they should be unusual with respect to nasality. This hypothesis is not unfounded, but it also seems wrong. Nasal clicks do not pattern like regular nasals in other phonological ways. Nasals are normally sonorants (e.g. [n]), but nasal clicks patterns like obstruents. Nasals are also known to trigger local spreading, or long-distance harmony, for nasality; it isn't clear that nasal clicks can do so. Nasals are also normally voiced, and rarely voiceless; but voiceless nasal clicks are rather common. Nasal clicks are also very commonly glottalized, but glottalized nasals are quite rare cross-linguistically. The point: nasal clicks don't obviously seem to work like nasals, for reasons independent of the universal in (2).

The proposition we are left with is that nasality seems marked in general, but unmarked for clicks. Why?

1.3 Proposal: click nasality is pulmonicity

The answer proposed in this paper is that the nasality of nasal clicks is not real phonological [+nasal]ity, but rather a phonetic consequence of routing pulmonic airflow around the two oral closures necessary to produce a click. This is formalized using the two airstream features in (3) which are defined aerodynamically. The crucial assumption (4) is that the combination of [+lingual] and [+pulmonic] results in nasal airflow, due to nasal venting – a mechanism considered in more detail in §3.

(3) Airstream features proposed
   a. [±lingual]: lingual airstream (cf. 'velaric')[3]
   b. [±pulmonic]: pulmonic airstream

(4) [+lingual, +pulmonic] → nasal airflow

(5) Featural classifications, illustrated

Representation	Example segments	Characterization
−lingual, +pulmonic	p t k b d g m n s χ w a ʔ (etc.)	vowels, other non-clicks
+lingual, −pulmonic	ʘ ǀ ǁ ǃ ǂ ǃʰ gǁ gǀχ ǃχ' (etc.)	oral clicks
+lingual, +pulmonic	nʘ nǀ nǁ n! nǂ n̥! ˀn̥ǁ ⁿǀʰ (etc.)	nasal clicks
−lingual, −pulmonic	Ø	(phonetically impossible)

According to this proposal, nasal clicks are not [+nasal] clicks; rather, they are [+pulmonic] clicks. This premise leads to an explanation for the permissibility of nasal clicks: [+pulmonic] segments are unmarked generally. Given these representational primitives, the typology of oral and nasal click distribution is

[3] I follow Miller et al. (2009) in using the term 'lingual' rather than 'velaric', since the velum has not all that much to do with producing this airstream mechanism. The definition of the [±lingual] feature differs from the one that Miller et al. propose, however; see §3.2.1 for discussion.

explained by a small set of simple markedness and faithfulness constraints, as §4 demonstrates.

The proposed analysis also offers new insights about why clicks have a peculiar affinity for glottalization (noted in previous work by Elderkin (1992) and others). The proposed phonetic implementation for the feature [+pulmonic] is lack of pressure build-up in the pharyngeal cavity. Low pharyngeal pressure is achieved primarily by nasal venting, but is phonetically enhanced by glottal gestures that reduce airflow into the pharynx – i.e. by glottalization and voicing. This ties up a loose end which is left unexplained by the alternative, null, hypothesis that nasal clicks are simply [nasal] (discussed further in §5).

2. The typology of click nasality

2.1 Methodology and basis for claims

The typological claims made here are based on a survey of as many languages with clicks as possible. The survey considered the click inventories of languages, either as noted explicitly in previous descriptive or analytical work, or inferred from published word lists of other documents. Where possible, the positional distribution of clicks was also recorded.

Approximately 45 languages were included in the survey. A more precise number here is problematic for several reasons. Most of the languages with clicks are Khoisan languages; most of these languages are highly under-documented, and available sources differ considerably in how much phonetic and phonological detail they offer. The family structure among this group of languages is also still not fully understood (see Sands 1995, Honken 2013, and Güldemann 2014 for background). Three other quirks of this group of languages are (i) that many of these languages have highly similar names, (ii) that different transcription conventions lead to a multitude of spellings of the same name, and (iii) that many languages go by different names in different sources (Treis 1998; see also Traill 1992, Bradfield 2014, Güldemann 2014:2ff). For example, !Xóõ and !Xũ are two different languages, from two different families. But !Xũ is also referred to as !Xung, !Xun, !Kung, or Kung, and !Xóõ as !Xoon or !xõ; alternate spellings of this sort are very common. Moreover, !Xóõ is also sometimes referred to by other unrelated names, such as Taa (Naumann 2008, 2014, etc.) and ǂhũa (Westphal 1971).[4] Additionally, many of the Named Languages described in the literature are actually dialect groups with rich internal variation: Naumann uses 'Taa' to refer to the whole !Xóõ dialect cluster, which includes a half-dozen or so different dialects, which are not all mutually intelligible – and which also have their own distinct endonyms. Since identifying languages by name from previous literature is not always fully reliable, combining data from multiple sources is a messy endeavour. For this reason, an appendix to the paper gives a list of languages treated as distinct for purposes of the survey, as well as the primary sources taken to be representative of them.

The term 'nasal' is used here to mean 'clicks produced with some kind of accompanying nasality'. This includes pre-nasalization, and nasality found during the click closure, or on the following vowel. This categorization is intended to include clicks described in previous work as 'nasal' or 'nasalized', as well as clicks that are systematically produced with nasality. I cast a wide descriptive net here because

[4] The name ǂhũa is also very similar to ǂHoan/ǂHõã, which is the name of another language – one related to !Xũ, and not to !Xóõ.

nasality associated with a click could be phonetically implemented in multiple ways – much like voicing in stops, which may involve voicing before, during, or after the stop closure (see Maddieson & Ladefoged 1993 for discussion). This means that clicks accompanied by nasality might also be interpreted, analyzed, and described in multiple ways: as nasal clicks (n!), or as a click preceded by a homorganic nasal (N+!), or as a click preceded or followed by nasal vowels (Ṽ!Ṽ). All of these are found in previous descriptions, and different reports about the same language often differ on this point. I treat them all as a category of nasal clicks, as distinct from oral clicks produced with no nasality.

2.2 Typology overview

Two dimensions of cross-linguistic variation are apparent in the survey. First, languages can differ in where clicks are allowed: some languages permit them only in root-initial or word-initial positions, while others allow them in onsets generally. Some languages also prohibit clicks in all positions – they have no clicks. Second, languages can differ in where clicks are allowed to be nasal and/or oral. This is where the !→n! implication emerges. Some languages allow only nasal clicks; others allow both oral and nasal clicks word-initially, but require non-initial clicks to be nasal; and some languages permit a nasal-oral contrast on clicks in any position where they are allowed. These two dimensions yield the typology summarized in (6).

(6) Typology of click nasality (? marks less-certain classifications)

	!...!	!...C	C…C
{n!, !}…{n!, !}	**Full nasality contrast** Hadza, Xhosa, Zulu, Ndebele, Fwe, Siswati, Sesotho, Ndebele, Ndau, Phuthi?, Old Ngoni?, Mbukushu?, Mzimba Tumbuka?	**Initial clicks only** Kxoe, ǁAni, G|ui, Gǁana, Naro, Tsua, Shua, Ts'ixa, Nama, Sesfontein Damara, !ora, ǂHoan, !Xũ, Mangetti Dune !Xung, Ekoka !Xun, Grootfontein !Xũ, Ju|'hoan, !Xóõ, ǁXegwi, |Xam, N|uu, K'u|ha:si?, Yeyi?	**No clicks** English, Spanish, German, etc.
{n!, !}…{n!}	**Medial click nasalization** Sandawe, Gciriku?, Kwangali?		
{n!}…{n!}	**Nasal clicks only** Dahalo, Afrikaans?, South African English?	**Initial nasal clicks only** Damin, Chinese, Digo, South African English?, Afrikaans?, Kinyarwanda?	

Some obvious logical possibilities are notably unattested. First, no languages have only non-nasal clicks. Second, no languages allow oral clicks more freely than nasal clicks.

The rest of this section considers each typological niche in more detail, and presents data from languages with each pattern.

2.3 Languages with only nasal clicks

The clearest example of a language with only nasal clicks is Dahalo, a southern Cushitic language spoken in Kenya (Tosco 1991). The facts reported here come primarily from Maddieson et al. (1993, 1999).

The click inventory of Dahalo is given in (7). The key generalization evident here is that all of the clicks are nasal. Some examples are given in (8) (Maddieson et al. 1993, 1999).

(7) Dahalo click inventory
n|̥ ~ ŋ|̥ ~ n|ʷ ~ (ŋ|ʷ)

(8) Dahalo examples:

a.	ŋ̥|óːne	'breast'	(initial nasal clicks)
b.	ŋ̥|íːtʼi	'gums'	
c.	ŋ̥|waːʔana	'knead, massage'	
d.	нaŋ̥|ana	'lick'	(medial nasal clicks)
e.	fuŋ̥|inna	'root up'	
f.	meŋ̥|eŋ̰e	'carefully'	

Clicks are not common in Dahalo, and so bear very little functional load. As such, the structure of the inventory is somewhat murky. There is no evidence for a contrast between different kinds of clicks, but both voiceless and voiced clicks have been recorded, as well as clicks with labial off-glides, all seemingly in free variation. Elderkin (1992) differs from Maddieson et al. (1993) in reporting both nasal and glottalized clicks ([n!] and [!ˀ]), but explicitly notes that the glottalized clicks are always accompanied by nasality.[5]

Dahalo is not unique in having only nasal clicks and no non-nasal ones. Glimmers of the same pattern can be seen in various other unrelated languages.

The most well-documented occurrence of clicks in a language outside of Africa comes from Damin, a secret language based on Lardil. Damin's phonological system is described in considerable detail by Hale & Nash (1997). The click inventory of Damin is given in (9).

(9) Damin click inventory (Hale & Nash 1997:252)

Bilabial	Lamino-dental	Apico-alveolar	Apico-domal
ŋʘ	ŋ|ŋ|	ŋ! ŋ!ŋ!	(ŋǂ)

There are 4 different types of clicks, produced with different types of front closures. All of them are nasal. Somewhat unusually, Damin makes a distinction between normal and 'rearticulated' clicks, the latter being produced with two click articulations back-to-back.[6] Hale & Nash (1997:255) note that non-click nasals are

[5] Ehret (2013) reports that Dahalo also has lateral clicks in some words. The data is in unpublished field notes, so no examples are available to me.

[6] The same rearticulation is also found on certain non-click consonants. For example. Hale & Nash (1997:252) also give the segment /tʲtʲ/, a re-articulated laminal stop. In some other sources, these are transcribed with a vowel between the clicks; for example where Hale & Nash give *n!2u* for a word referring to all liquids, Dixon (2002:92) gives the same word as *n!un!u*.

extremely restricted. While Lardil has [n̪ n ɳ ɲ ŋ], Damin's nasals are limited to [ŋ] (which does not have an obvious correspondent among the clicks), word-final [n], and [ɲ] in the cluster [fɲ].

Hale & Nash observe that there is no possibility for contrast between the clicks and the nasal non-clicks; on the basis of this, they posit a general rule that nasals in Damin are realized as clicks where possible (i.e. when they are onsets). However, there is good reason to be skeptical of taking this on par with other reported phonological rules. It is not the case that there are alternations between clicks and nasals, nor are Damin words are derived from Lardil ones by such a process. Indeed, Damin roots do not appear to derive from Lardil ones at all. Instead, there is a small number of roots (approximately 150), many of which have very general meanings that are modified by compounding to produce stems that bear no phonological relationship to Lardil stems (see Hale 1973, 1982, Hale & Nash 1997 for more detailed discussion). The only real cognates between Lardil and Damin are inflectional affixes; which are fully identical and never include clicks.

Regardless of how Damin came to have clicks, the fact remains that it is a language that has nasal clicks, but lacks oral clicks. The same pattern is also found in a number of mutually unrelated languages where clicks are more marginal.

Walsh (2006) attests 4 words in Digo (a Bantu language spoken on the Tanzania/Kenya border) that include clicks; all of them have the nasal click [n|].

Nathan (2001) documents insertion of clicks in a Chinese nursery rhyme, replicated by speakers of two different dialects (Mandarin & Ningdu). The three speakers Nathan recorded inserted nasal clicks at the start of words for 'duck' or 'goose'.

Nasal clicks are also attested in at least one slang word [n!a ~ n|a ~ n|an|a] 'nice, good, lekker' used in both South African English and Afrikaans. This lexical item is putatively a borrowing (likely from Xhosa), but is used by speakers who are not proficient in any African language.[7]

Finally, Kinyarwanda has intrusive clicks in certain nasal+consonant clusters (Demolin & Delvaux 2001, Demolin 2016). While it is by no means clear that intrusive clicks of this sort should be treated on par with clicks that are intentionally produced in lexical items, the fact remains that all of these clicks are produced with accompanying nasality. On the surface, then, Kinyarwanda is like Dahalo: it has nasal clicks, but no oral clicks.

2.4 Medial click nasalization

A second pattern of central interest is found in Sandawe, a language isolate spoken in Tanzania. The key generalization is that while oral and nasal clicks are both found in word-initial position, non-initial clicks are always nasal (noted previously by Tucker et al. 1977, Elderkin 1992, Wright et al. 1995, Eaton 2006, and Hunziker et al. 2008).

The click inventory of Sandawe is given in (10) following the descriptions of (Wright et al. 1995, Eaton 2006), along with the featural analysis I assume.

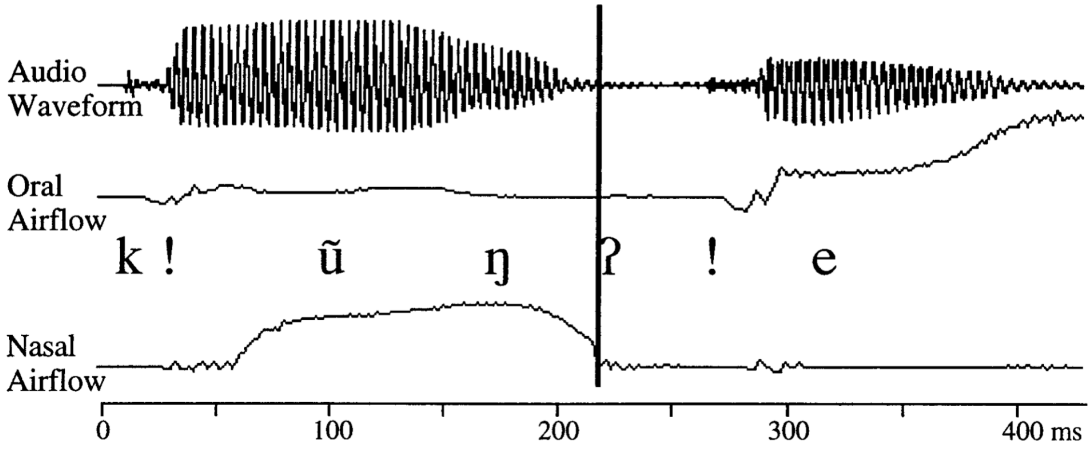
[7] I thank Andries Coetzee for sharing his Afrikaans intuitions, and Mark de Vos for sharing his SA English intuitions.

(10) Sandawe click inventory

	Dental	Lateral	Post-Alv.	Analysis	
Voiceless	|	‖	!	[−pulmonic]	[−voice]
Voiced	g|	g‖	g!		[+voice]
Aspirated	|^{h}	‖^{h}	!^{h}		[+s.g.]
Voiced, nasal	n|	n‖	n!	[+pulmonic]	[+voice]
Glottalized, nasal	n̥|ʔ	n̥‖ʔ	n̥!ʔ		[−voice]

Sandawe has three types of clicks distinguished by different anterior places of articulation, cross-classified into five sets of clicks distinguished by their laryngeal properties and nasality. Two of those sets have consistent nasality: the '(voiced) nasalized' clicks and the 'glottalized' clicks. The latter are characterized as being creaky, and also having predictable nasalization on preceding vowels (Elderkin 1992, Wright et al. 1995). This nasality is clearly evident from nasal airflow measurements taken by Wright et al. (1995), as shown in (11). I take these clicks to be nasal, and analyze them as [+pulmonic].

(11) Glottalized clicks are nasal (diagram from Wright et al. 1995:14)



Sandawe only permits a nasal-oral contrast for clicks in word-initial onsets, where all five sets of clicks are possible (12). Word-medial clicks in Sandawe are always nasalized (13). (Examples from Wright et al. 1995, Eaton 2006, Hunziker et al. 2008.)

(12) Word-initial onsets: nasal and oral clicks are both possible

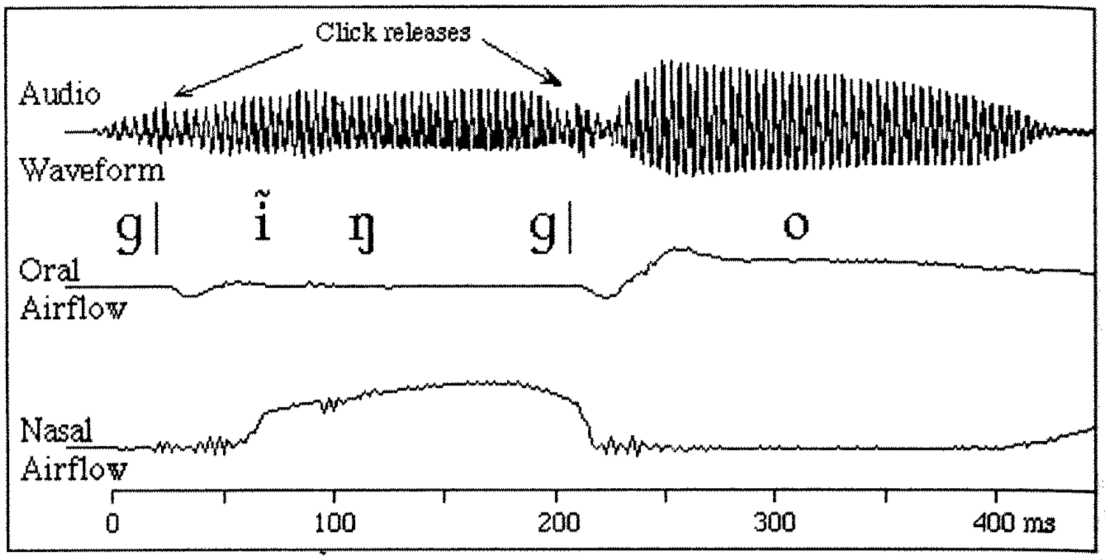
a. ‖ŏː 'path'
b. g‖ő̃ːn‖ê 'greater kudu (male)'
c. ‖hâː 'to brush off'
d. n‖ŏː 'child'
e. ‖ʔŏː 'harvest'

(13) Word-internally, all clicks are nasal:

a.	sén‖á	‘tree (type)’
b.	k’án!á	‘to lose’
c.	n|an|aʔo	‘to cut’
d.	hóŋ̊‖ʔó	‘to fill’
e.	hóŋ̊!ʔô	‘forehead’
f.	máŋ̊|ʔâ	‘to crumble’
g.	má:ŋ̊|ʔâ	‘louse’

Previous work on Sandawe includes some apparent exceptions to the generalization asserted here. These are words transcribed with medial oral clicks. For example, Wright et al. (1995) give the word [g|**ig**|o] for a type of finch, which seems to contain a medial oral [g|]. However, most of these apparent counter-examples are transcribed with an oral click following a nasal vowel. This suggests that such clicks are indeed nasalized, but that the nasality has been analyzed as belonging not to the click, but to a neighbouring segment instead. For those counter-examples where more detailed data is available, this nasality is abundantly clear. For the ‘g|ig|o’ example, the nasal airflow trace that Wright et al. (1995) provide shows that the medial oral click in this word is actually nasalized. I analyze – and transcribe – oral clicks with nasality like this one as being simply nasal clicks.

(14) “[g|ig|o]” = [g|in|o] (Wright et al. 1995:11)



The nasality of medial clicks in Sandawe cannot be attributed to a phonotactic requirement that holds over nasals generally. Medial non-clicks exhibit a distinction between nasal, prenasalized, and oral segments (15). (Examples from Hunziker et al. 2008.)

(15) Sandawe medial non-clicks can be either nasal or oral

a.	kótó	‘thorn fence’
b.	ké^{n}tó	‘callous skin’
c.	hònà	‘to harvest honey’

Furthermore, a number of animal names look like they may be possible reduplications, on the basis of having identical onsets in the first two syllables (16)

(examples from Kagaya 1993, Wright et al. 1995). In such words, medial clicks are completely identical to the initial clicks in all respects *except* nasality: the medial clicks are always nasal, even if the initial clicks are oral. This suggests that the absence of medial oral clicks is not an accidental gap; words like these make sense as reduplications that have been altered to fit the phonotactic requirement that medial clicks be nasal.

(16) Apparent reduplications in Sandawe have medial nasal clicks

a.	xoːxori	'crow'
b.	ɬaɬaŋge	'chameleon'
c.	n̥‖ˀòn̥‖ˀá	'baboon'
d.	g|ǐːn|óː	'type of finch'
e.	g‖óːn‖ê	'greater kudu (male)'

Sandawe therefore appears to be a language that admits both oral and nasal clicks, but permits only the nasal clicks in the non-privileged non-initial position.

Sandawe is not alone in its typological niche: the same pattern may also be found in Rumanyo, a Bantu language from the Caprivian area of southern Angola, and in particular in the Gciriku dialect (Möhlig & Shiyaka-Mberema 2005, Möhlig 2009, 2013, Bostoen & Sands 2012). There are five clicks in Gciriku (17), including both nasal and oral clicks. Möhlig (2013) reports that the place of clicks varies, but is most commonly dental.

(17) Click inventory of Gciriku (Möhlig 2013, Möhlig & Shiyaka-Mberema 2005)

	IPA	orthography
voiceless, oral	| ~ !	'c'
voiced, oral	g| ~ g!	'gc'
voiceless, prenasalized	n̥| ~ n̥!	'nc'
voiced, prenasalized	n| ~ n!	'ngc'
prenasalized, aspirated	n̥|ʰ	'nch'

All five clicks are found in stem-initial position. In stem-non-initial position, clicks are almost always nasal. Möhlig's (2009) provides a list of 128 click words, drawn from Möhlig & Shiyaka-Mberema's (2005) dictionary. There are 16 items with non-initial clicks; 8 of these show reduplication of the first syllable or the full stem (e.g. [vi-|a|a] 'wood chips for kindling', analyzable as /vi-|a-|a/). The remaining 8 are given in (18) below. Only two have oral clicks; one of these looks like a possible reduplication, while the other appears to have a fossilized prefix [mu-]. The rest show the same pattern found in Sandawe: the medial clicks are nasal.

(18) Medial nasalization in Gciriku? (examples from Möhlig 2009)

a.	-|án|ʰanita	'chase after'
b.	-|ún|unuka	'be hairless, featherless, leafless'
c.	-|ún|una	'remove hair, feathers, leaves'
d.	–g|ên|uka	'be neglected (by husband)'
e.	–g|ên|una	'neglect one's wife'
f.	li-g|uvan|é	'Johnson's topminnow' (*Aplocheilichthys johnstoni*)
g.	|ég|a	'traditional bed'
h.	ka-mug|ará	'yellowbilled oxpecker'

The same pattern might also hold for Kwangali, another Bantu language in the same area as Gciriku (but not from the same family), though less data is available to substantiate it. Möhlig (2009) notes, based on a search of a Kwangali dictionary (Damann 1957) that Kwangali has many fewer words with clicks, and that most of them are similar or identical to words also in Gciriku (see also Bostoen & Sands 2012 on this comparative point). Möhlig's list has 21 Kwangali click words that are not similar or identical to Gciriku ones. Two of these have medial clicks, both nasal. While we should of course be cautious in extrapolating from such limited data, the facts available seem to echo the same pattern seen in Sandawe above.

Sandawe and Gciriku are two languages from opposite sides of the African continent, with little in common other than that both have clicks. But both languages have the same restriction on nasality in clicks.[8]

2.5 Full nasal/oral contrast

A third pattern is also present in the typology: languages that make an oral ~ nasal contrast on clicks in all positions where they are permitted to occur. Two sub-cases comprise this niche of the typology, differentiated by where clicks are permitted more generally. Some languages permit both oral and nasal clicks, but restrict all clicks to a privileged word-initial or stem-initial position.[9] Other languages permit clicks in non-initial onsets as well, and make the oral ~ nasal contrast available in all positions.

Hadza, a language isolate spoken in Tanzania, exhibits a full oral ~ nasal contrast in clicks. Data and generalizations given here come mainly from (Tucker et al. 1977, Elderkin 1992, Sands et al. 1996, Maddieson et al. 1999, Sands 2013). The click inventory of Hadza is given in (19).[10] The nasality of the glottalized clicks in the third row is reported by Tucker et al. (1977) and Elderkin (1992), and confirmed by more rigorous observation by Sands et al. (1993, 1996).

(19) Hadza click inventory (Sands et al. 1996, Maddieson et al. 1999, Sands 2013)

	Dental	Lateral	Post-alveolar	Analysis
Voiceless, oral	ǀ	ǁ	!	[−pulmonic]
Voiced, nasal	nǀ	nǁ	n!	[+pulmonic]
Glottalized, nasal	n̰ǀˀ	n̰ǁˀ	n̰!ˀ	

[8] The same pattern of medial nasality is also evident in a subset of the lexicon of isiXhosa (a Bantu language from southeastern South Africa). Nearly all words that have multiple clicks in Xhosa have two clicks with the same place of articulation (cf. Sibanda 2004). I know of two stems that do have two different types of clicks. They are [-!ʰakan|u] 'Khoisan language/culture' and [!on|e], a place name. In both, the medial click is [n|]. While this is admittedly scant evidence to reason from, it is consistent with an intriguing generalization: medial clicks must either agree with a stem-initial click, or be nasalized. (Credit for this observation is shared with Olwethu Zeleni and Douglas Smith, who each independently identified the relevant words in undergraduate research projects.)

[9] Discerning between word-initial and stem-initial is impossible in some of these languages because they lack prefixes.

[10] Some other earlier and later sources report more clicks. Specifically, Bleek (1956) and Tucker et al. (1977) include more click types. A recent dictionary (Miller et al. 2013) also includes aspirated clicks, but aspiration may be predictable from position and other segments in the root (Kirk Miller and Bonny Sands, p.c.).

The essential generalization in Hadza is that any onset can have an oral or nasal click. Some examples are given in (20), showing that oral and nasal clicks can both be found in both initial and medial positions.

(20) Hadza examples (Sands et al. 1996, Miller et al. 2013)

a.	ǀʰatamu	'yellow-billed stork'	(ˇ!V; initial oral)
b.	!aku	'to jump over'	
c.	ǀaǀa	'large, flat rock'	
d.	kaǁa	'to hunt'	(ˇCV!V; medial oral)
e.	ke!ʰena	'be slow'	
f.	ʔeǁekeke	'to listen'	
g.	nǀatʰa	'tongue'	(ˇn!V; initial nasal)
h.	n̥ǁˀoʔo	'wash, bathe'	
i.	n!ana	'species of mongoose'	
j.	kʰan̥ǁˀe	'to jump'	(ˇCVn!V; medial nasal)
k.	tʰan̥ǀˀe	'belt'	
l.	binǁo	'carry bunch of dead mice/etc. in one's belt while hunting'	

The same pattern of click distribution is also found in many other languages, particularly the Bantu languages of the Nguni family, such as Xhosa (Tshabe et al. 2006), Zulu (Doke 1926), Swati (Ziervogel 1952, Taljaard et al. 1991, Malambe 2006), and Ndebele (Sibanda 2004). In all of these languages, nasal and oral clicks both occur in both stem-initial and stem-medial positions.

There are also other languages that have a full contrast between oral and nasal clicks, but restrict both to word-initial or stem-initial position. This is typical of most Khoisan languages (Doke 1925, Greenberg 1966). !Xóõ is an example (Traill 1985, 1994; see also Naumann 2008, Bradfield 2014). !Xóõ has an exceedingly large consonant inventory, including nearly 40 non-clicks, and 80 distinct clicks.[11] !Xóõ's very large click inventory comes from having 17 different sets of clicks (5 of which are nasalized), which cross-classify across 5 click types (distinguished by the place of the front closure). All clicks are found in word-initial position, and the vast majority of lexical items start with clicks. However, !Xóõ roots are maximally CVCV in shape, and the medial consonant is restricted to only [b m n ɲ j l r]. So, !Xóõ has a full nasal/oral contrast, but there is limited opportunity to observe it, because clicks are permitted only in one privileged prosodic position to begin with.

The same pattern from !Xóõ might also be attested in Yeyi, a Bantu language spoken in the Caprivi strip (near the borders of Namibia, Botswana, and Zambia) (as noted previously by Seidel 2008:46). Yeyi is an endangered language, and previous work by Fulop et al. (2000, 2003) shows that different speakers often use different clicks in the same words, and have quite different click inventories in the aggregate. All speakers consulted by Fulop et al. (2003) did produce multiple types of both nasal and oral clicks, though. Some examples are given in (21), showing that a range of

[11] These numbers are based on Traill (1985); the consonant inventories in later work (Traill 1994, Naumann 2008, etc.) include additional segments above and beyond these. But they appear to be marginal and very rare, so I do not count them here.

different kinds of clicks do occur in stem-initial position. (All speakers studied by Fulop et al. made at least this five-way contrast in at least the dental and alveolar click types.

(21) Stem-initial nasal ~ oral contrast in Yeyi (Fulop et al. 2003)
a. ku-n|amisa 'to give breast (suckle)'
b. ku-|'akasa 'to drizzle'
c. ku-|ara 'to cut open'
d. ku-g|awa 'to cut grass'
e. wu-|ˣiki 'one'

Stem-internal clicks are much less common in Yeyi. From the available data,[12] it seems they may be found only in compounds or in stems where the initial syllable is reduplicated. Some examples are given in (22) below. The stem in (a) is fully reduplicated; the stem in (b) reduplicates only the first syllable. The pair of words in (c) and (d), 'sunrise, morning' and 'sunset, evening', look like compounds, since they share same final component /-!umu/.[13]

(22) Yeyi medial clicks may be stem-initial (examples from Fulop et al. 2000)[14]
a. u-ǂʰamu-ǂʰamu 'weak'
b. ku-ᵑ!ˀu-ᵑ!ˀuna 'to knock'
c. ma-kʰwe-ŋ̊ˀ|ˀumu 'sunrise, morning'
d. ʃɪ-ku-ŋ̊ˀ|ˀumu 'sunset, evening'

A search of a Yeyi dictionary (Lukusa 2007) turns up a few dozen words with medial clicks, but the majority of these have a reduplicated structure like either (22a) or (22b) above. The rest are based on just nine stems, which include the two likely compounds in (22c) and (22d) above. Further empirical work is of course needed, but it would not be surprising if the other seven also turn out to have compound structure. If this speculation is borne out, Yeyi would be a Bantu language that has the same stem-initial restriction on clicks as is found in many Khoisan languages.

In sum, what we see in looking at Hadza, Xhosa et al., and !Xóõ (and perhaps also Yeyi) are a range of languages from wildly different areas, with no particularly close genetic relationship between them, all manifesting the same pattern of oral ~ nasal click contrast.

2.6 Conspicuously unattested patterns

Two patterns of click distribution are conspicuously absent from the observed typology. There are no languages which have only oral clicks, and lack nasal clicks – the opposite of the pattern seen in Dahalo. There are also no languages that permit

[12] This includes word lists assembled by Sommer & Vossen (1992), Fulop et al. (2000, 2003); a dictionary by Lukusa (2009), and a grammar by Seidel (2008).

[13] It is worth noting that this potential root /-!umu/ looks nothing like the word Lukusa (2009) gives for 'sun', [[i:wá], which looks to be of Bantu origin. It is, however, somewhat similar to the word for sun in ǁAni, [|ám] (Heine 1999).

[14] I have adapted the word in (22b) to a broader transcription; the original given by Fulop et al. is [kũʔ kˀ!ˀũʔkˀ!ˀũna], with nasality marked not on the clicks themselves, but on the vowels adjacent. Also, Fulop et al.'s (2000) transcriptions show inter-speaker variation in the type of click found in 'sunrise' and 'sunset'; I have given it as dental here, following Sommer & Vossen (1992) and Lukusa (2009).

oral clicks more broadly than nasal clicks – the opposite of Sandawe. Taken together, we are left with the implicational universal !→n!. This implication holds over consonant inventories generally. It also holds across positions. Languages vary in where they allow clicks; but, wherever clicks are allowed, nasal clicks are allowed – but not necessarily oral clicks.

It is worth mentioning that some superficially apparent counter-examples can be found in the literature. I claim that these are only apparent, and not genuine counter-examples.

One category of potential counter-examples are languages for which extremely little data is available. An example is Tumbuka, a Bantu language spoken in northern Malawi (Sands & Gunnink 2016, Moyo 1995). Moyo (1995) notes that the Mzimba dialect of Tumbuka has clicks due to past influence from Nguni languages, and mentions three words with clicks as examples. I know of no other data available on the Mzimba dialect specifically. While the three words Moyo gives all have oral clicks, the absence of more data isn't a good reason to think that Mzimba Tumbuka is a language that allows oral clicks but not nasal clicks. For one, the source language that these clicks were presumably borrowed from is Old Ngoni, a language known to have nasal clicks based on contemporaneous descriptions (see Sands & Gunnink 2016). Moreover, other languages where clicks are extremely marginal do conform to the !→n! implication evident from the typology. Fwe (a Caprivian Bantu language) is an interesting comparison here. Gunnink (2013, forthcoming) reports that roughly 50 Fwe words may have clicks; these clicks are always in free variation with non-click consonants (e.g. [^{n}du-|oma] ~ [^{n}du-koma] 'type of reed'). But even in a highly impoverished click system like this, we find nasal clicks ([mu-n|api] ~ [mu-^{ŋ}kapi] 'type of frog'). This comparison suggests that if we had dozens more Mzimba words with clicks, we could be reasonably confident that we would find nasal clicks in some of them.

The second category of potential counter-examples arises from choices about terminology and analysis made in descriptions.[15] Siswati is a clear example. Malambe (2006) – who is a native Siswati speaker – gives a consonant inventory that includes only [| |^{h} g|], and does not include any nasal clicks. However, other sources on Siswati (Taljaard et al. 1991, Ziervogel 1952) clearly state that there are nasal clicks in the language, found in words like [in|ola] 'wagon'; these are also found in Malambe's examples, e.g. [umn|^{w}aɓo] 'funeral' (Malambe 2006:103). Malambe omits nasal clicks from the Siswati consonant inventory not because they are absent from the language, but rather because she regards them as /N+|/ clusters, and does not list clusters in the inventory. On the surface, Siswati does indeed have nasal clicks as well as oral ones – even though some reports imply otherwise.

3. Deriving nasality from pulmonicity

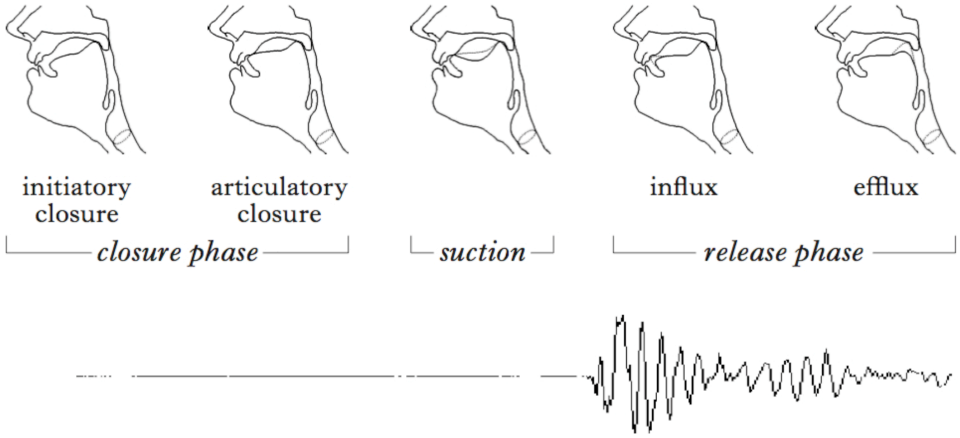
3.1 Basics of click production

The basic mechanism of click production is relatively well-understood, having been studied in some detail for nearly a century (see Doke 1923, Ladefoged & Traill 1984, 1994, Ladefoged & Maddieson 1996, Miller et al. 2009, among others). The process involves three essential stages, depicted in (23) (diagram from Dogil & Mayer

[15] I thank an anonymous reviewer of a much earlier draft of this work for bringing this flexibility of interpretation to my attention.

1998:169). First, two closures are formed, sealing off a cavity in the mouth. The resulting cavity is then enlarged, creating suction. This suction creates a loud and highly distinct burst when the front closure is released. This click burst may be accompanied by other elaborations on the release of the back closure, such as (af)frication or a second burst.

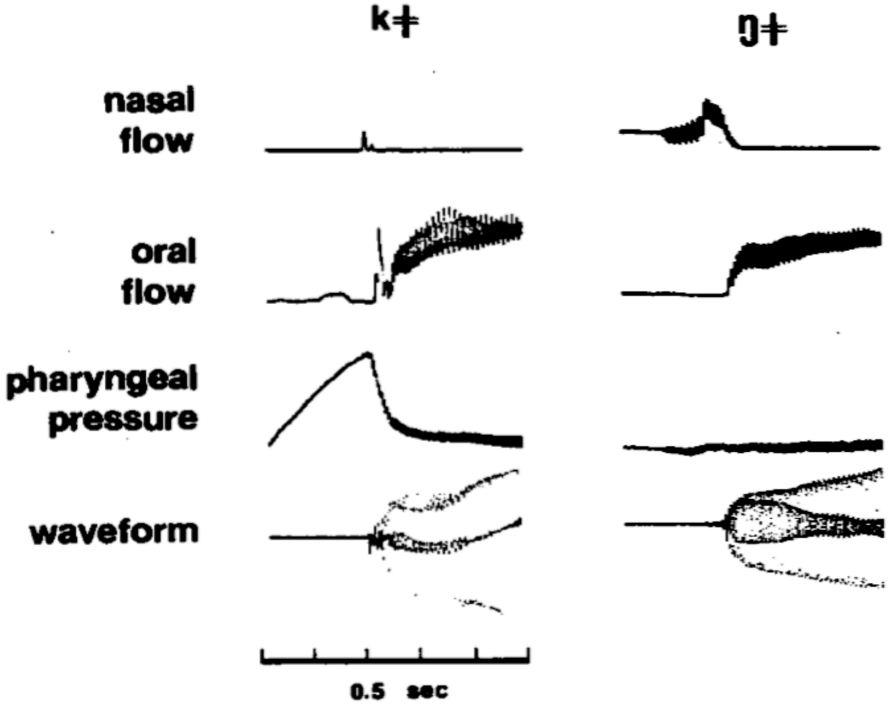
(23) Articulatory sequence for click production



This articulatory mechanism has consequences for pulmonic airflow. Creating the suction for a click requires two lingual closures in the oral cavity. This entails that the oral cavity is fully sealed during a click. If the velum is also raised during a click – blocking the nasal cavity and precluding nasality – then the vocal tract is fully closed off. This means that pulmonic airflow out of the lungs can only flow into the pharynx, causing build-up of pharyngeal pressure until equilibrium is reached and airflow must stop. Lowering the velum during a click creates a vent for airflow to escape through: pulmonic airflow isn't stopped at the pharynx, because air can continue to flow through the nasal cavity. Venting of this sort creates an acoustic effect similar to [ŋ] or [ɴ]: there is a dorsal closure in the velar/uvular region, and airflow through the nasal cavity.

The point to take away is this: in clicks, nasality goes hand-in-hand with pharyngeal pressure. The illustrations in (24) (taken from Ladefoged & Traill 1984:7) show this trade-off in action, based on measurements from two types of clicks in Nama (Khoekhoe). The click on the left is oral; it has a clear pharyngeal pressure build-up before release. The nasal click on the right has no pharyngeal pressure increase. Nasal airflow avoids an increase in pharyngeal pressure, and vice versa; the velum controls both facets of a click simultaneously. If a click is fully oral, then it cannot have normal pulmonic airflow. To produce an oral click in the context of neighbouring pulmonic sounds (e.g. vowels), the pulmonic airstream must be de-activated from the source.

(24) Oral and nasal clicks in Nama (Khoekhoe) (Ladefoged & Traill 1984)



The claim advanced here is that the nasality of [ŋ‡] is secondary; it is present only as a means to keep the pharyngeal pressure low, and allow normal pulmonic airflow to be maintained during the click. [ŋ‡] is not [+nasal]; the phonetic nasality is the consequence of being [+lingual, +pulmonic].

3.2 Formalizing the airstream features

Based on the proposal that click nasality is due to pulmonic venting, we can define the features for the lingual and pulmonic airstreams as follows:

(25) Phonetic implementation of lingual airstream
- a. [+lingual] → lingual suction in oral cavity (audible from resulting burst)
- b. [–lingual] → absence of lingual suction (audible from lack of click-like burst)

(26) Phonetic implementation of pulmonic airstream
- a. [+pulmonic] → low/neutral pharyngeal pressure, allowing continued pulmonic airflow
- b. [–pulmonic] → high pharyngeal pressure, pulmonic airflow blocked

It is necessary to differentiate between the pharyngeal cavity and the oral cavity. For the sake of concreteness, I take the oral cavity to be the space located behind the major Place constriction of a consonant, and take the pharyngeal cavity to be the space in the pharynx, above the glottis. In click consonants, these are distinct: a segment like [!] has its oral cavity located behind the alveolar (front) constriction, and the pharyngeal cavity is separated from this by the back closure formed with the dorsum. In stops that only have one constriction, the two cavities are non-distinct. For example, the articulation of [t] does not have a distinct pharyngeal cavity. As such, a normal [t] has neutral pharyngeal pressure: air pressure in the uvulo-pharyngeal space may increase, but does not do so separately from the pressure in the oral cavity;

simple stops like [t] are therefore [+pulmonic], as are ordinary nasals like [m]. Nasal clicks are also [+pulmonic]; because the velo-pharyngeal port is open, pharyngeal pressure is also neutral. In oral clicks, however, pharyngeal pressure is high; this is what makes [!] [–pulmonic].[16]

3.2.1 Relation to previous proposals

The mechanism of nasal venting in clicks is also mentioned in previous work by Traill (1991) and others. The crucial claim made by Traill (1991) is that nasal venting reveals that 'delayed aspiration' clicks in !Xóõ have pulmonic ingressive airflow through the nasal cavity. He considers nasal venting to be a phonetic mechanism that occurs in some clicks (as it also does in some plosives), not the result of a [nasal] feature. The proposal made in this paper goes a step further in a similar direction: nasality in clicks in general is due to the venting mechanism, not just the nasality observed in delayed aspiration clicks.

It should also be noted that some previous work on clicks (Miller et al. 2009, Miller 2011) likewise posits both lingual and pulmonic airstream features, but does so in an importantly different way. I adopt the same names 'lingual' and 'pulmonic' for the airstream features proposed here, since 'pulmonic' is the most straightforward name for a feature that represent pulmonic airflow. The [lingual] feature used here is more or less the same as the one they posit, but the [pulmonic] feature is significantly different. Miller et al. (2009) define [pulmonic] acoustically, rather than aerodynamically, and use it to distinguish different sets of clicks. That proposal is based in part on ultrasound data from N|uu. Previous (mostly impressionistic) descriptions of N|uu and related languages report a contrast between different sets of clicks on the basis of the location of the posterior closure: 'plain' clicks like [!] and other were thought to have a velar back closure, while other clicks like [!q] had a uvular one. Miller et al. (2009) find that all both of these types of clicks actually have uvular posterior closures; there is no place distinction to be made between them. Instead, the distinction appears to be that in [!q], the release of the back closure has an audible burst, absent in [!]. Accordingly, they analyze clicks like [!q] (and its affricated counterparts like [!χ]) as [+pulmonic], with the phonetic implementation of [+pulmonic] being the presence of a pulmonic burst or frication. Crucially, the [±pulmonic] feature used here is not defined in that way. Though the definitions of [pulmonic] are different, the proposals based on them are not incompatible – they posit two different features, which are realized in different ways, and are implicated in different phonological contrasts.[17]

It is also worth noting that deriving nasality from features other than [nasal] has precedents in earlier work too. For example, Grijzenhout (2001) proposes a distinction between two kinds of nasal stops: one with the traditional representation [+son, +cons, +nasal], and a 'light nasal stop' which is merely [+son, +cons], and lacks a [nasal] specification. Instead, these light nasal stops are nasalized essentially due to nasal venting: the feature [+sonorant] requires voicing, and the only way to maintain voicing during an oral closure is to vent air around the oral cavity via the nose. Grijzenhout argues that nasals which trigger nasal harmony are true [+nasal]

[16] A full analysis of ejectives is outside the scope of this paper, but the notions of pharyngeal cavity and pulmonicity developed here might be understood to categorize ejectives as [–pulmonic].

[17] Alternatively, the clicks that Miller et al. (2009) characterize as pulmonic could be analyzed as clusters (see Traill 1985, Güldemann 2001, Nakagawa 2006, etc.).

segments, while nasals that fail to induce harmony are light nasal stops, thereby explaining a curious distinction in Acehnese. While I don't subscribe to that proposal here, I do observe that most languages with nasal clicks do not have nasal spreading – something which is consistent with the idea that their nasality does not arise from a [+nasal] feature.

3.2.2 Why is nasal venting needed in clicks but not stops?

Crucially for the proposal, non-clicks like [t] are [+pulmonic], as noted above. But since an oral stop like [t] also involves fully sealing up the vocal tract – just as an oral click does – we might wonder why they are not subject to venting to maintain pulmonic airflow, in the same way that nasal clicks do. While stops frequently *do* involve nasal venting, it appears to be only to a very small degree (see, e.g. Yanagihara & Hyde 1966, Ohala 1983, Ohala & Ohala 1993, Traill 1991, etc.); not to anywhere near the same extent presumed for clicks. There are a range of potential reasons why clicks would be different in this way.

First, clicks involve posterior closures that are rather far back, typically in the uvular region (Miller et al. 2009, Miller 2011). This means that a click has a much smaller cavity behind the closure than in a stop like [p] or [t] or even [k]. Continuous airflow into a smaller cavity results in a faster pressure increase, and therefore shorter time before equilibrium is reached and airflow into the cavity stops.

Second, because the posterior cavity of a click is smaller than a typical stop, there is also less soft tissue available for passive expansion. In a [t] it is possible to expand the cheeks to maintain airflow for longer; not so for a click.

Third, the lingual airstream mechanism also interferes with some normal processes that can enlarge the cavity for a stop. A click requires suction. This not only mandates the creation of two oral closures, it also requires that lingual cavity to be enlarged. If the tongue root is involved in producing this suction, it could only do so by moving backwards – thereby further shrinking the pharyngeal cavity. Even if the posterior closure does not retract, it must be maintained, which requires stiffening of the tongue root and body, leaving that tissue unable to help with passive expansion.

Fourth, in at least some languages, clicks seem to have longer closure durations than is typical for stops. For example, Traill's (1993:140) measurements from four speakers of !Xóõ show basic clicks having an average duration of 175 ms. This is only slightly longer (3%) than the average duration of pulmonic stops in !Xóõ, but is considerably longer than average closure durations for stops like [t] in many other languages. Moreover, since clicks bursts normally have a shorter duration than non-click releases, this small distinction likely belies a larger difference in closure duration.

In sum, the situation in clicks is summed up by a remark that Ohala (1983:197) attributes to Chao (1936): "Between the velum and the glottis, there is not much room to do any of the tricks that can be done with the larger cavity for a **b** or a **d**." The cavity behind the posterior closure of a click is considerably smaller than that of a typical stop; it is less prone to passive expansion, and may even be subject to contraction; and it must be held for a longer duration. Taken together, these reasons lead us to expect clicks to be much more prone to more nasal venting than ordinary stops.

3.2.3. Consequences for the larynx

With the phonetic implementation of [+pulmonic] defined as non-elevated pharyngeal pressure, the use of nasal venting to avoid pressure increase makes sense. But there is

another logically possible way to avoid increasing pharyngeal pressure: to push less air into the pharyngeal cavity. Constricting the glottis offers a way to do that. Assuming pressure on the lungs (e.g. from the diaphragm) is constant, a smaller glottal opening results in less throughput. Voicing and glottalization are ways to reduce the size of the glottal opening. We might, therefore, expect both of these to work in concert with nasal venting, as a secondary phonetic enhancement gesture (in the sense of Stevens, Keyser & Kawasaki 1986, and Keyser & Stevens 2006; see also Ohala 1983, Ohala & Ohala 1993).

The resulting expectation is that voicing and/or glottalization should serve as phonetic enhancement of [+pulmonic], at least in clicks. This appears to be borne out typologically: nasality in clicks does indeed have a strong co-occurrence with voicing and/or nasality. Miller (2011) identifies eight different species of attested nasal clicks, listed in (27). The first five of these eight involve either glottalization or voicing. One of the remaining three, voiceless and non-glottalized [n̥!], is attested in only two languages. One is Dahalo, in which all clicks are variably voiced or voiceless (as noted in §2); the absence of voicing is not contrastive. The other is !Xóõ, which has a three-way contrast for voicing and glottalization, in which [n̥!] contrasts with other sets of voiced and glottalized nasal clicks.

(27) Types of attested nasal clicks (Miller 2011:422)

IPA	Description
n!	Voiced nasal click
n!ʰ	Voiced nasal aspirated
ˀn!	Preglottalized nasal
n̥!ˀ	Voiceless nasal glottalized
n!g	Prenasalized voiced
n̥!	Voiceless nasal
n̥!ʰ	Voiceless nasal aspirated
n̤!	Murmured nasal

4. Explaining the typology

The point of this section is to demonstrate that given the representation of nasal clicks as [+lingual, +pulmonic] (i.e. as pulmonic clicks), the typology of oral and nasal click distribution can be explained in a straightforward and elegant way.

4.1 Constraint definitions

The constraint set posited here includes two markedness constraints, and four faithfulness constraints, defined as follows.

Markedness:

(28) ***[+lingual]**: For every segment X in the output, assign 1 violation if X is [+lingual]

(29) **Agree(pulmonic)**: For every distinct pair of segments X,Y in the output, assign 1 violation if:
X is [+pulmonic], *and*
Y is [-pulmonic], *and*
X and Y are adjacent segments

Faithfulness:
(Where X is an output segment, corresponding to input segment X')

(30) IDENT-Onset (lingual): assign 1 violation if:
X & X' have different values of [±lingual], *and*
X' is an onset

(31) IDENT-Initial (lingual): assign 1 violation if:
X & X' have different values of [±lingual], *and*
X' is a stem-initial onset

(32) IDENT-Onset (pulmonic): assign 1 violation if:
X & X' have different values of [±pulmonic], *and*
X' is an onset

(33) IDENT-Initial (pulmonic) assign 1 violation if:
X & X' have different values of [±pulmonic], *and*
X' is a stem-initial onset

The overall scheme of this theory closely resembles previous analyses of other more well-studied phenomena, in particularly Lombardi's (1999) analysis of voicing in codas and clusters (see also Baković 2000 on AGREE constraints). The essential function of the AGREE(pulmonic) constraint is to penalize non-nasal clicks when they are next to pulmonic segments. Oral clicks violate this constraint except when they are produced in isolation, without adjacent pulmonic segments (e.g. in paralinguistic usage). This creates a pressure for all clicks in words to be nasal. The function of the Ident constraints for [pulmonic] constraints is to protect oral clicks from becoming nasalized. In much the same way, *[+lingual] prohibits clicks; they are permitted only where protected by IDENT constraints for [lingual].[18] All of the faithfulness constraints are positional (à la Beckman 1998), but lack non-positional counterparts. That is, I assume there is no general IDENT(lingual) constraint; this is key to deriving the correct factorial typology.

The 'initial' position picked out by IDENT-Initial(pulmonic) and IDENT-Initial(lingual) is a conflation of several different domains that are not easily pried apart. Aside from Bantu, most languages that have clicks happen not to have many prefixes, which makes it virtually impossible to distinguish between different domains. The generalization in !Xóõ, for instance, is ambiguous: it could be that clicks are limited to word-initial position, or to stem-initial position, or to root-initial position. In the absence of compelling evidence to recognize each of these as distinct positions, I conflate them all. In languages that do have prefixes, particularly Bantu languages like Zulu, I presume that the IDENT-Initial constraints target the stem-initial position.

4.2 Factorial typology

The six constraints defined above form two subsets. The constraints that refer to the [±lingual] feature govern where clicks occur. The constraints referring to [±pulmonic], on the other hand, govern nasality of clicks. Both of these subsystems

[18] In this respect, the theory is quite similar to Beckman's (1998:194ff) account of click distribution in Zulu: clicks are not found in affixes, because they are prohibited generally, and are only protected in roots.

have the same structure: they consist of a single markedness constraint, and two positional faithfulness constraints in a stringency relation.

4.2.1 Occurrence of clicks

The constraints that refer to [lingual] control where clicks are allowed. These give rise to only three distinct patterns, shown below. If *[+lingual] dominates both faithfulness constraints, then clicks are prohibited, as shown in (34). Even if we assume a rich base that includes inputs that have clicks, these would be neutralized to [−lingual] segments on the surface (represented here arbitrarily as [k]).[19] This ranking explains languages like English, where clicks are prohibited.

(34) *[+lingual] ≫ IDENT-Initial(lingual), IDENT-Onset(lingual): no clicks

Input:	!a!a	*[+lingual]	IDENT-Initial(ling)	IDENT-Onset(ling)
☞ a.	kaka	(0)	(1)	(2)
~ b.	!aka	**W** (0~1)	**L** (1~0)	**L** (2~1)
~ c.	!a!a	**W** (0~2)	**L** (1~0)	**L** (2~0)

If *[+lingual] is dominated by at least one of the faithfulness constraints for [±lingual], the result is a grammar that allows at least some clicks. If only IDENT-Initial(lingual) dominates *[+lingual], then clicks are permitted only in initial onsets. Underlying non-initial clicks would be neutralized to [−lingual] non-clicks. This is shown in (35). This ranking derives the pattern seen in languages like !Xóõ and Yeyi, where clicks are restricted to stem-initial position.

(35) IDENT-Initial(lingual) ≫ *[+lingual] ≫ IDENT-Onset(lingual): clicks allowed in initial onsets

Input:	!a!a	IDENT-Initial(ling)	*[+lingual]	IDENT-Onset(ling)
~ a.	kaka	**W** (0~1)	**L** (1~0)	**W** (1~2)
☞ b.	!aka	(0)	(1)	(1)
~ c.	!a!a		**W** (1~2)	**L** (1~0)

Finally, if IDENT-Onset(lingual) dominates *[+lingual], the result is a language that allows clicks in onsets generally (not just initially). This is shown in (36). The ranking of IDENT-Initial(lingual) does not matter here, because its violations are a subset of those assigned by IDENT-Onset(lingual). This derives the distribution of clicks in languages like Zulu, Xhosa, Hadza, Sandawe, Dahalo, and other languages where clicks may occur in the onset of any syllable of a stem.

[19] The specific mappings responsible for eliminating clicks are difficult to adduce. An anonymous reviewer will surely point out that since [k] is [+pulmonic] and [!] is not, mapping /!/→[k] involves more than just the constraints on [±lingual]. If faithfulness for [±pulmonic] is also undominated, the intuitive result of eliminating an oral click would be a segment that is [−lingual, −pulmonic] – one that has no airstream mechanism at all. I assume here that GEN freely produces candidates with such segments, but that they are impossible to realize phonetically. Including such candidates is necessary for deriving the right typology. Optima involving these impossible segments might be thought of as a failed or ineffable utterance.

(36) IDENT-Onset(lingual) ≫ *[+lingual]: clicks allowed in onsets

Input:	!a!a	IDENT-Initial(ling)	IDENT-Onset(ling)	*[+lingual]
~ a.	kaka	W (0~1)	W (0~2)	L (2~0)
~ b.	!aka		**W** (0~1)	**L** (2~1)
☞ c.	!a!a	(0)	(0)	(2)

No ranking of the constraints on [lingual] can produce a language that allows clicks in coda positions; as such, the theory predicts that clicks should be universally impossible in codas. There is admittedly little data to go on, but from the data available, the prediction appears to be correct: there are no substantiated reports of clicks in syllable-final positions (an observation made previously by Hale & Nash 1997:255). A few sources transcribe occasional word-final clicks, but all describe them as ending with a highly reduced vowel (see, for instance, Tucker & Bryan 1977:309; Hunziker et al. 2008:64; see also Sands et al. 1993, Eaton 2006). However, most of the languages that have clicks also happen to have quite restricted syllable structures, with most or all obstruents being prohibited in coda positions in any case.[20] For example, so it is not clear whether any languages specifically prohibit clicks in codas.

4.2.2 The distribution of click nasality

The constraints that refer to the feature [pulmonic] control click nasality. The interactions between them have the same structure as seen in the constraints on [lingual], and also produce a three-pattern typology. If AGREE(pulmonic) is undominated, then [−pulmonic] (i.e. oral) clicks are prohibited in all words. This is shown in (37): even a hypothetical input with oral clicks would be forced to neutralize them to nasal clicks. This derives the pattern seen in languages like Dahalo, where all clicks are nasalized.

(37) AGREE(pulmonic) ≫ IDENT-Initial(pulmonic), IDENT-Onset(pulmonic): all clicks are nasal

Input:	!a!a	AGREE(pulm)	IDENT-Initial(pulm)	IDENT-Onset(pulm)
☞ a.	n!an!a	(0)	(1)	(2)
~ b.	!an!a	**W** (0~1)	**L** (1~0)	**L** (2~1)
~ c.	!a!a	**W** (0~3)	**L** (1~0)	**L** (2~0)

If either of the faithfulness constraints for [±pulmonic] dominates AGREE(pulmonic), then oral clicks are allowed – at least in some circumstances. If only IDENT-Initial(pulmonic) dominates AGREE(pulmonic), then oral clicks are protected from nasalization only in initial positions; clicks in non-initial positions are still

[20] More specifically, many Khoisan languages allow only [m n ŋ] as codas (including !Xũ, Kxoe, ǁAni), and most Bantu languages with clicks are the same. The most extensive codas are found in Nama and !ora, which allow [m n p/b s ts] (see also Elderkin 2014 for discussion of this point).

required to be nasal. This is shown in (38), and derives the pattern observed in Sandawe and Gciriku, where non-initial clicks are required to be nasal.[21]

(38) IDENT-Initial(pulmonic) ≫ AGREE(pulmonic) ≫ IDENT-Onset(pulmonic): medial click nasalization

Input:	!a!a	IDENT-Initial(pulm)	AGREE(pulm)	IDENT-Onset(pulm)
~ a.	n!an!a	**W** (0~1)	**L** (1~0)	**W** (1~2)
☞ b.	!an!a	(0)	(1)	(1)
~ c.	!a!a		**W** (1~3)	**L** (1~0)

Finally, if IDENT-Onset(pulmonic) dominates AGREE(pulmonic), then clicks in any onset are allowed to be oral. This ranking is shown in (39), and it yields the full contrast pattern seen in languages like Hadza and Xhosa, where both initial and non-initial clicks can be either oral or nasal.

(39) IDENT-Onset(pulmonic) ≫ AGREE(pulmonic): full oral ~ nasal contrast in clicks

Input:	!a!a	IDENT-Initial(pulm)	IDENT-Onset(pulm)	AGREE(pulm)
~ a.	n!an!a	**W** (0~1)	**W** (0~2)	**L** (3~0)
~ b.	!an!a		**W** (0~1)	**L** (3~1)
☞ c.	!a!a	(0)	(0)	(3)

Crucially, there is no ranking of the constraints that allows for click *de*-nasalization. This is harmonically bounded. None of the constraints penalize clicks for being [+pulmonic]. As such, there is no way for an underlyingly [+pulmonic] click to be neutralized to a [−pulmonic] one. This is shown in (40): for an input with a nasal click, a candidate that unfaithfully maps it to an oral click is worse on all constraints than faithful realization as a nasal click.

(40) Click de-nasalization is harmonically bounded.

Input:	n!a	IDENT-Initial(pulm)	IDENT-Onset(pulm)	AGREE(pulm)
☞ a.	n!a	(0)	(0)	(0)
☹ b.	!a	**W** (0~1)	**W** (0~1)	**W** (0~1)

This captures the absence of patterns that are the reverse of Sandawe and Dahalo. The only way a language can prohibit nasal clicks is by clicks generally. As such, it is impossible for a language to have only oral clicks, and impossible to allow oral clicks more widely than nasal ones. This is an appealing result, because such patterns are not attested.

[21] Here again the nature of the mappings is not fully determinable from available data. I presume that Sandawe enforces its phonotactic pattern by nasalizing oral clicks in medial positions. The candidate [!an!a] in (39b) harmonically bounds alternatives like [!aka] that reduce offending oral clicks to non-clicks, because this involves unfaithfulness for [±lingual] as well as [±pulmonic].

4.2.3 Combined typology

The combined typology predicted based on the two constraint subsystems is given in (41). All of the predicted patterns are attested in the typological survey from §2.

(41) Predicted typology

	ID-Ons(pulm) ≫ AGREE	ID-Init(pulm) ≫ AGREE ≫ ID-Ons(pulm)	AGREE ≫ ID-Ons(pulm), ID-Init(pulm)
ID-Ons(ling) ≫ *[+lingual]	**Full contrast** Hadza, Xhosa, etc.	**Medial nasalization** Sandawe, Gciriku	**Nasal clicks only** Dahalo
ID-Init(ling) ≫ *[+lingual] ≫ ID-Ons(ling)	**Initial clicks only** !Xóõ, Nama, G|ui, Yeyi, etc.		**Initial nasal clicks only** Chinese, Digo, etc.
*[+lingual] ≫ ID-Init(ling), ID-Ons(ling)	**No clicks in words** Br./Amer. English, etc.		

5. True [+nasal]ity is not a viable alternative analysis

There is an obvious alternative to the account proposed here: why not simply treat nasal clicks as [+nasal]? This would be a simpler theory, in that it does not require a new [±pulmonic] feature. On the surface, it also seems – at least intuitively – like it could draw on much of the same theoretical apparatus, preserving the basic results. Rather than positing an AGREE(pulmonic) constraint, we could posit a constraint that enforces the preference for nasal clicks more directly, such as *[+lingual, –nasal]. The nasal venting mechanism discussed in §3.2 could even be seen as a direct functional motivation for such a constraint, connecting to that idea in much the same way as AGREE(pulmonic) does.

There are two problems with this simpler account, however. First, it does not generate the same typological predictions as the theory proposed above when the constraints on clicks are freely allowed to interact with constraints on other features. Second, it leaves us without any satisfying explanations for key languages of interest like Dahalo and Sandawe.

5.1 The typological predictions are not the same

In the account proposed above, the !→n! implication is explained by pulmonic segments being less marked than non-pulmonic ones. If nasal clicks are represented as [nasal] rather than [+pulmonic], we do not obtain this result.

The reason is that [+pulmonic] can be treated as universally unmarked, but [+nasal] is clearly not so. Previous comparative work on nasality has identified a number of languages that lack any [+nasal] segments, even allophonic ones (Cohn 1993). Such outright prohibitions against nasality are suggestive of constraints that militate against [+nasal]. Work on nasal spreading (Walker 1998) also supports the need for a family of constraints that penalize [+nasal] segments to the exclusion of oral segments. As long as there are such constraints, it is impossible to derive the universal that [+nasal] clicks are allowed wherever oral clicks are.

For the sake of a concrete illustration, let us assume the existence of the constraint *NAS/OBSSTOP (42), as proposed by Walker (1998). I assume here that clicks are non-continuants, and that they are obstruents (see Miller-Ockhuizen 2003, Miller 2011 on the status of clicks as obstruents).

(42) *NAS/OBSSTOP: *[+nasal, –continuant, –sonorant]
'assign 1 violation for each output segment that is [+nasal], [–continuant], and [–sonorant]'

In order to allow clicks, faithfulness for [lingual] must dominate *[+lingual]. If *NAS/OBSSTOP dominates both of these constraints, the result would be a language that prohibits nasal clicks, as shown in (43), while still allowing oral clicks to surface faithfully (44).

(43) Nasal clicks are prohibited

Input:	n!a	*NAS/OBSSTOP	IDENT-Onset(ling)	*[+lingual]
☞ a.	!a	(0)	(0)	(1)
☹ b.	n!a	**W** (0~1)		e (1~1)
~ c.	ka	e (0~0)	**W** (0~1)	**L** (1~0)

(44) Oral clicks are allowed to surface faithfully

Input:	!a	*NAS/OBSSTOP	IDENT-Onset(ling)	*[+lingual]
☞ a.	!a	(0)	(0)	(1)
☹ b.	n!a	**W** (0~1)		e (1~1)
~ c.	ka	e (0~0)	**W** (0~1)	**L** (1~0)

What's happening here is that nasal click are prohibited not because they are clicks, but because they are nasal obstruents. Meanwhile, oral clicks are permitted to surface faithfully: because they are not [+nasal], they satisfy *NAS/OBSSTOP. Such a language could also still allow [+nasal] sonorants: because they are not [−sonorant], they do not violate *NAS/OBSSTOP. Languages like this are unattested. The pulmonicity proposal correctly predicts this. But, as long as there is *any* constraint that penalizes nasal clicks and does not also penalize oral clicks, that prediction is lost.

5.2 Understanding Sandawe and Dahalo

In addition to failing to predict the correct typology, the [+nasal] analysis of nasal clicks leaves key languages of interest unexplained, particularly Sandawe and Dahalo.

In Sandawe, non-initial clicks are invariably nasal; non-clicks are not subject to this requirement (as illustrated in §2.4 above). The proposal set out in this paper explains the Sandawe pattern as reduction to [+pulmonic] in non-initial positions. But if nasal clicks are [+nasal] rather than [+pulmonic], we are left with a rather arbitrary interpretation of the generalizations. Clicks, and only clicks, are required to be [+nasal] in stem-medial position. This cannot be attributed to some kind of nasal assimilation, nor dissimilation, because it holds irrespective of whether a word contains any other nasals.

Dahalo is also rendered mysterious. It has nasal clicks, but no oral clicks. If we take nasal clicks to be simply [+nasal] clicks, then we are forced to assume that Dahalo's inventory contains more-marked clicks to the exclusion of less-marked ones. Since Dahalo is not alone in having this asymmetry in its inventory; the same pattern recurs in a number of unrelated languages (Damin, Chinese, Digo). The [+nasal]

analysis of clicks offers no insights about why this should be the case. Instead, this kind of pattern would be on par with a language having pre-nasalized stops, but lacking plain oral stops. By contrast, such a pattern falls out for free from the [+pulmonic] analysis of click nasality, because [+pulmonic] consonants are universally unmarked.

5.3 Is there a role for [±nasal] in clicks?

If nasality in clicks is explained by the feature [+pulmonic], then what role does the feature [±nasal] play? A reduced one, presumably. One appealing possibility is that [±nasal] could be responsible for distinctions between different kinds of phonetically nasalized clicks – a split between 'true' nasal clicks that are genuinely phonologically [+nasal], as opposed to phonetically nasal clicks that are actually [−nasal]. This would seem very much in line with the limited role that nasality plays for non-click obstruents, and perhaps could more shed light on why nasal clicks so often do not pattern with non-click nasals (as noted in §3.2 above). Languages with numerous different kinds of nasal(ized) clicks, such as !Xóõ, provide ample opportunities to test this speculation further in future work.

6. Conclusion

The central claims of this paper are two. The first is empirical in nature: oral clicks universally imply nasal clicks. Wherever non-nasal clicks may occur, nasal ones are also found – but not vice versa. The second claim is about featural representations: nasal clicks are not [+nasal] clicks, but rather [+pulmonic] clicks. The nasality of these segments comes from nasal venting needed in order to maintain a [+pulmonic] specification – and the continued pulmonic airflow it represents – in the face of multiple oral closures. Given this representation, an explanation of the !→n! universal emerges with little further stipulation. Pulmonic consonants are unmarked, so the !→ n! implication is a special case of a more general non-pulmonic → pulmonic implication. This explanation relies on a standard markedness type of interaction, familiar from other categories of (non-click) segments. Oral clicks imply nasal clicks in much the same way that voiced obstruents imply voiceless ones, and so on.

Appendix

The table below lists the languages included in the typological survey, along with the main sources consulted about each. This list of sources is not intended as an authoritative list. Languages are grouped according to the distribution of nasality in clicks: languages with only nasal clicks are first, followed by languages with medial nasalization, then those with full oral ~ nasal contrast. Languages with no click consonants (e.g. only para-linguistic usage) are not included.

Language	Source(s)	Remarks
Nasal clicks only		
Dahalo	Tucker et al. 1977, Elderkin 1992, Maddieson et al. 1993	Southern Cushitic, Kenya. Nasal clicks only. Medial clicks infrequent but attested. See §2.3.

Damin	Hale & Nash 1997; Hale 1973, Hale 1982	Ceremonial language, possibly constructed. Related to Lardil (Tangkic family). Spoken in Australia. Clicks only in root-initial position. See §2.3.
Chinese	Nathan 2001	Ningdu and Mandarin varieties. Clicks inserted in nursery rhyme; always nasal, only word-initial. See §2.3.
Digo	Walsh 2006	Bantu, Kenya. Clicks very marginal, all stem-initial. See §2.3.
Kinyarwanda	Demolin & Delvaux 2001, Demolin 2016	Bantu, Rwanda. Intrusive clicks in /N+N/ clusters at stem onset. All click bursts accompanied by nasality. See §2.3.
Afrikaans	(own data)	Germanic, South Africa; historically no clicks. Word-initial nasal click in one or more lexical items. Possibly word-medial in reduplicated forms. See §2.3.
South African English	(own data)	Germanic, South Africa; historically no clicks. Word-initial nasal click in at least one lexical item. Possibly word-medial in reduplicated forms. See §2.3.
Medial click nasalization		
Sandawe	Tucker et al. 1977, Elderkin 1992, Kagaya 1993, Wright et al 1995, Maddieson et al. 1999, Eaton 2006, Hunziker et al. 2008	Isolate, or possibly distantly related to Khoe (see Sands 1995, Güldemann & Elderkin 2003). Spoken in Kenya. Medial clicks always nasal. See §2.4.
Gciriku	Möhlig 2009, Möhlig & Shiyaka-Mberema 2005, Möhlig 2013	Bantu, Caprivi region. Gciriku is a dialect of (Ru)Manyo. Stem-initial oral/nasal clicks, but only nasal clicks stem-medially (some exceptions; see §2.4).
Kwangali	Damann 1957, Westphal 1971, Möhlig 2009, Bostoen & Sands 2012	Bantu, Caprivi region. Alternate name: Kwangari. Clicks rare. See §2.4. Medial clicks more often nasal than not, but exceptions exist.
Full contrast, clicks in initial position only		
Kxoe	Vossen 1997, Güldemann 2001, Killian-Hatz 2008	Khoisan, Kalahari Khoe West, Caprivi region. Alternative names: Khwe, Khoe. Cluster of multiple dialects, including at least Búma-khwè, Búga-khwè, ǁóm̀-khwè, ǁó-khwè, and ǁAni.
ǁAni	Vossen 1986, Heine 1999	Khoisan, Kalahari Khoe West, Caprivi region. Part of Kxoe dialect cluster.
G|ui	Nakagawa 2006	Khoisan, Kalahari Khoe West, Botswana.
Gǁana	Maingard 1961, Nakagawa 1998, Vossen 1997, Chebanne 2014	Khoisan, Kalahari Khoe West, Botswana.

Naro	Visser 1998, 2001, Vossen 1997, Maingard 1961, 1963	Khoisan, Kalahari Khoe West, Botswana. Alternate names: Naron, Nharo. Medial clicks exist in compounds. Multiple dialects, including ǀamkhoe, ǁaikwe, possibly also ǂHaba.
Tsua	Vossen 1997, 2013, Mathes 2015, Maingard 1963, Chebanne 2014	Khoisan, Kalahari Khoe East. Alternate names: Tsoa, Tshwa, Cua, Hietshware, Sarwa. Multiple dialects, including Kua. In dialect continuum with Shua.
Shua	Vossen 1997, 2013, Mathes 2015, Chebanne 2014	Khoisan, Kalahari Khoe East, Botswana. Alternate name: Hietshware. Multiple dialects, including: Deti, Danisi, Cara, ǀXaise.
Ts'ixa	Fehn 2014, Vossen 2013	Khoisan, Kalahari Khoe East, Botswana. In Shua dialect cluster.
Nama	Brugman 2009, Beach 1938, Hagman 1977	Khoisan, Northern Khoekhoe, mainly spoken in Namibia. Alternate names: Khoekhoe, Khoekhoegowab, Damara, 'Hottentot' (obsolete). Multiple dialect groups, including Haiǁom, and ǂĀkhoe.
Sesfontein Damara	Haacke 1986, Job 2014	Khoisan, Northern Khoekhoe, Namibia. In the Khoekhoegowab dialect continuum, but with extensive phonological differences from other varieties.
!ora	Beach 1938, Ponelis 1975, Killian 2009	Khoisan, Southern Khoekhoe, South Africa. Alternate names: Korana, Xiri, Griekwa, Khoemana.
ǂHoan	Bell & Collins 2001, Collins & Gruber 2014	Khoisan, Kx'a family, Botswana. Part of larger dialect cluster that includes ǂ'Amkoe, Sàsí, N!aqriaxe.
!Xũ	Westphal 1971, Snyman 1980, 1997, Miller 2011	Khoisan, !Xun family, Namibia, Botswana, Angola (Caprivi region). Alternate names: !Kung, !Xuun. Multiple dialect groups.
Mangetti Dune !Xung	Miller 2016	Khoisan, !Xun family, north(west)ern dialect cluster, Namibia.
Ekoka !Xun	König & Heine 2001	Khoisan, !Xun family, north(west)ern dialect cluster. Originally spoken along Angola-Namibia border.
Grootfontein !Xũ	Doke 1925, Miller 2011	Khoisan, !Xun family, central dialect cluster, Namibia.
Juǀ'hoan	Snyman 1975, Dickens 1994, Miller-Ockhuizen 2003	Khoisan, !Xun family, (south)eastern dialect cluster, Namibia and Botswana. Alternate names: Juu, Juǀ'hoansi, Zhuǀ'hõasi. Multiple dialects.
!Xóõ	Traill 1985, 1994, Naumann 2008, 2014	Khoisan, Taa family, Botswana. Alternate names: Taa, !Xoon. Includes East and West dialects.
K'uǀhaːsi	Traill 1999, Güldemann 2013	Khoisan, Taa family, South Africa. Extinct. Alternate name: ǀHaasi.

ǁXegwi	Lanham & Hallowes 1956, Güldemann 2013	Khoisan, !Ui family, eastern South Africa. Alternate names: Eastern Bushman, Batwa. Likely extinct.
|Xam	Bleek 1928, 1956, Güldemann 2013	Khoisan, !Ui family, South Africa. Extinct.
N|uu	Miller et al. 2009, Doke 1936	Khoisan, !Ui family, South Africa. Alternate names: ǂKhomani, Nǁng, ǁ'au, N|uuki.
Yeyi	Sommer & Vossen 1992, Fulop et al. 2000, 2003, Lukusa 2009, Seidel 2008	Bantu, zone K, Caprivi region. See §2.5. Click inventories and click words vary between speakers. Apparent word-medial clicks may all be in stem-initial positions.
Full contrast, initial & medial positions		
Hadza	Tucker et al. 1977, Sands et al. 1993, 1996, Maddieson et al. 1999, Miller et al. 2013	Language isolate, spoken in Tanzania. Alternate name: Hatsa.
Xhosa	McLaren 1942, Sands 1991, Tshabe et al. 2006, Jessen & Roux 2002	Bantu, Nguni family. Spoken mainly in South Africa. Alternate name: isiXhosa. Multiple dialects.
Zulu	Doke 1926	Bantu, Nguni family. Spoken mainly in South Africa. Alternate name: isiZulu. Multiple dialects.
Ndebele	Sibanda 2004, Schulz & Laine 2016	Bantu, Nguni family, Zimbabwe and South Africa. Alternate names: Sindebele, Isindebele. Multiple dialect groups; click loss observed in at least one dialect.
Fwe	Gunnink 2013, Sands & Gunnink 2016	Bantu, Caprivi region. Spoken in Namibia. Clicks rare and marginal.
Siswati	Malambe 2006, Ziervogel 1952, Taljaard et al. 1991	Bantu, Nguni family. Spoken in South Africa and Swaziland. Alternate names: Swati, Swazi.
Mbukushu	Bostoen & Sands 2012, Westphal 1971, Wynne 1980	Bantu, zone K, Caprivi region. Clicks rare.
Sesotho	Bourquin 1951, Westphal 1971, Jacottet 1972	Bantu, Sotho-Tswana family, Lesotho and South Africa. Alternate name: Sotho.
Phuthi	Donnelly 2007	Bantu, Nguni family, Lesotho & South Africa. Most clicks are stem-initial. Donnelly's word list includes one stem (-mon|uka) with a medial nasal click. Other medial clicks are possible compounds or reduplicated forms (e.g. n!an!ajilana 'ankle').
Old Ngoni	Sands & Gunnink 2016	Bantu, Nguni family, Malawi. Clicks marginal, too little data available to determine full distribution.

Ndau	Sands & Gunnink 2016, Borland 1970	Bantu, Shona family, Zimbabwe and Mozambique. Clicks marginal, too little data available to determine full distribution.
Mzimba Tumbuka	Sands & Gunnink 2016, Moyo 1995	Bantu, Malawi. Clicks marginal, too little data available to determine full distribution. See §2.6.

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