crease would have been observed.) Clicks of this type do not occur as phonological contrasts in Xhosa or other Nguni languages, but Lanham (1964) notes that the voiceless unaspirated stop in Xhosa may be followed by a glottal stop.

We have so far discussed seven ways (five in Xhosa and two others in Nama) in which the posterior component (the accompaniment) of a click can be varied. Several additional accompaniments occur in !X6o. Words illustrating the complete set of !X6o clicks (including some sequences of clicks and other consonants) are give in table 8.4. As we have noted, !X6o has five types of click articulation; there are bilabial, dental, alveolar, lateral, and palatal clicks. Each click has one of 17 possible accompaniments, which are exemplified in the table.

Waveforms for the alveolar click series are shown in figures 8.10 and 8.11. These words were recorded at Lokalane in the Kalahari Desert, in a free field, about a kilometer away from the settlement. The slight background noise which is evident during voiceless closures is the unavoidable sound of the wind in the trees. In order to get visually comparable waveforms we used representative utterances made by one speaker in a single recording.

We should note here that linguists are not agreed on the most appropriate way of symbolizing click accompaniments (Kohler, Ladefoged, Traill, Snyman and Vossen 1988). The symbols used in table 8.3 (and in all similar tables in this book) are an attempt at a systematic approach in accordance with the principles of the International Phonetic Association (1989). Every click involves a back closure, but since it may be either velar or uvular in place this aspect of a click must be written separately. This is done by writing a symbol for a velar or uvular consonant before the symbol for the click type. (The ordering of symbols does not indicate that the articulatory gestures are necessarily ordered in the corresponding way.) Other features of the click, such as presence or absence of voicing, as well as presence or absence of nasal air flow are indicated by choosing between, k, g, g, ɴ and so on. We have observed the following possibilities: k, g, g, g, g, ?g, q, ɢ. The click itself is symbolized using the IPA (1989) approved symbols. Different releases of the posterior closure are noted when necessary by an additional symbol after the symbol for the click. Possibilities include aspiration ^{h}, affrication ^{x}, and a glottal release either in the form of a glottal stop $^{?}$, or with a glottalic airstream mechanism forming

voiceless unaspirated accompaniment, it is the same as the click in Nama which we have already discussed. The voiceless unaspirated click in row (2) of figure 8.10 has a vowel onset very similar to that in the voiced click above it, but it has no voicing during the closure. The !X6o voiceless aspirated click in line (3) is also similar to that found in Nama. The duration of the aspiration is fairly extensive, well over 100 ms in this example.

The clicks in lines (4) and (5) have uvular accompaniments. In these clicks, the back of the tongue is in the uvular region at the time of release of the posterior closure. Clicks with this type of release are found in only a very few languages such as !X6o and ||Ani (Vossen 1986). We have followed a convention of regarding a velar accompaniment as the unmarked case, and have usually referred to the clicks we have been considering as, e.g., voiced, rather than voiced velar. When there is a uvular accompaniment it will be specifically mentioned. The voiced uvular plosive accompaniment (4) and the voiceless unaspirated uvular plosive accompaniment (5) are the direct counterparts of the velar accompaniments (1) and (2). However, there is less voicing for the voiced uvular, and slightly more aspiration for the voiceless unaspirated uvular. The release of the uvular closure also occurs slightly later with reference to the release of the anterior click closure. Traill (1985: 126) notes that the velar release is so soon after the click that it is not audible, but the uvular release is a separate event. Perhaps because it is difficult to sustain voicing throughout a uvular stop, voiced clicks of the form G! are often prenasalized and might be transcribed as NG!. In some tokens, by the time of the release of the click there is no voicing, and it is not until about 30 ms later that vocal fold vibrations can be seen. Ladefoged and Traill (1984) transcribed clicks of this form as N!G, noting, however, that the nasalization can be very short and that this click may be regarded as the voiced counterpart of q'.

!X6b has the voiced velar nasal (in row 6) that we have discussed above in relation to Nama, and also two other nasal accompaniments in rows (7) and (8) in figure 8.10. Row (7) shows a voiceless velar nasal accompaniment in which there is a strong nasal airflow. Spectrograms show that in this sound the release of the anterior closure (the click) occurs towards the end of the voiceless nasal, about 20 ms before the voicing commences.

A glottalized nasal accompaniment is exemplified by the word in row (8).

5	qOou 'wild cat'	q|aa 'rub with hand'	q!ae 'hunt'	q||aa 'thigh'	q+aa 'conceal'
6	gOdo 'louse'	g|aa 'see you'	rjlaa 'one's peer'	Qllaa 'grewia berry'	q+aa 'peer into'
7	qOa?a 'be close together'	rj|u?i 'be careful'	g!a?m 'evade an attack'	g||a?m 'be damp'	g+u?a 'be out of reach'
8	?gOaje 'tree'	?g|aa 'to suit'	?g!an 'Ue horizontal'	?rj||aha 'amount'	?gfau 'right side'
9	gO^{h}dd 'smeared with dirt'	0|^{h}aa 'look for spoor'	q!^{h}ai 'fall'	Q||^{h}aa 'carry'	g^aa 'ahead'
10	kO'dd 'walk slowly'	k|*aa 'dance'	k!*aa 'go a distance'	k||'aa 'scrape'	k^Aaa 'mind out'
11	gOkxana 'make fire with sticks'	g|kxaa 'splatter water'	glkxan 'soften'	g||kxa?n 'calf muscle'	g^kxa?a 'sneeze'
12	kO'q'om 'delicious'	k|'q'aa 'hand'	kl'q'aa 'spread out'	k||'q'aa 'grass'	k^'q'au 'neck'
13	gOq'66 'fly'	glq'aa 'chase'	glq'aa 'cry incessantly'	g||q'aa 'tumor'	g+q'aa 'ground to powder'
14	gOhoo 'sp. bush'	g|haa 'stale meat'	g!haa 'thorns'	g||haa 'bone arrow tip'	g+haa 'cut'
15	kO?oo "be stiff'	k|?aa 'die'	k!?aa 'be seated' [pl.]	k||?aa 'not to be'	k±?aa 'shoot you'
16	qO'um 'close mouth'	ql'an 'small' [pl.]	qi'ama 'stickgrass'	qll'ujia 'turn one's back'	q+'an 'lay down' [pl.]
17	—	G|had 'put into'	clhajia 'grey haired'	G^hae 'push away'	—

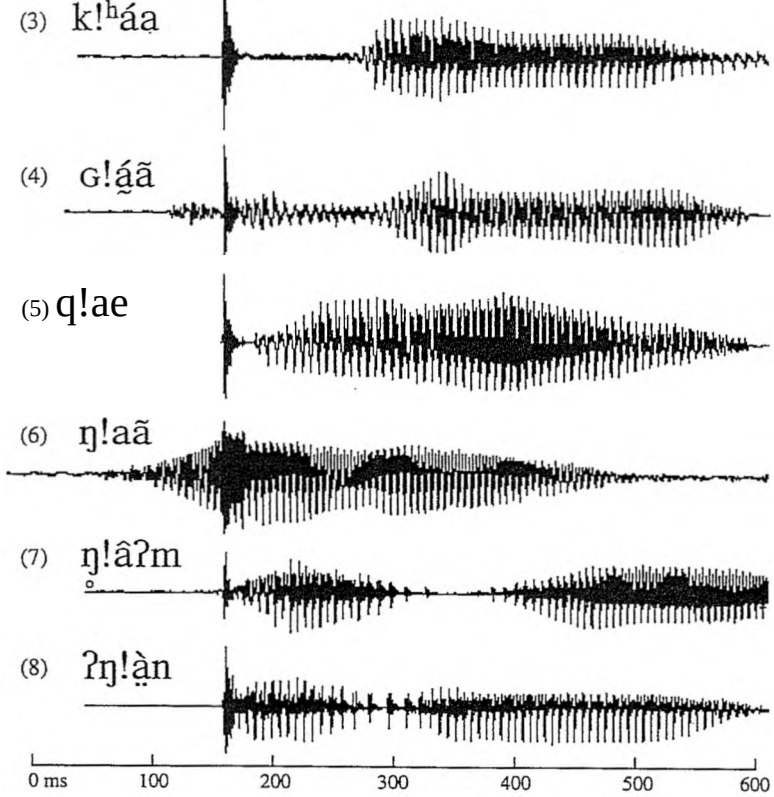


Figure S.10 Waveforms showing the first eight alveolar dicks in IXoo in table 8.4.

we have noted, all the examples in this figure are taken from a single recording of one speaker, resulting in this one not being as typical as we would have wished.) The glottalization can be seen in another token of the same word shown in figure 8.11. The preglottalized nasal is usually very short (about 50 ms) with the dick burst occurring near the middle of the nasal. The irregularities in the first three or four glottal pulses are evident in the waveform in figure 8.11, which is shown on a slightly expanded scale. In this case the click occurs about 30 ms into the nasal, and the waveform for the vowel appears as soon as the high frequencies associated with the dick can no longer be seen.

The remaining click accompaniments in !X66 are shown in figure 8.12. Row (9) shows the voiceless aspirated velar nasal accompaniment (delayed aspiration) which is also found in Nama. In these clicks, after the release of the anterior closure there is a long period of voicelessness (about 150 ms in the citation forms such as those in the figure 8.12), in the latter part of which weak aspiration may become more evident. Ladefoged and Traill (1984) note that the dicks with voiceless nasal aspiration in !X6o are similar to those in Nama, but they could not hear a voiceless velar nasal in citation forms; it is also not visible on the waveforms or in spectrograms of these sounds. The !Xo6 sounds also differ from the corresponding sounds in Nama, in that the !X66 nasal often remains voiceless even when the click is preceded by a vowel, although Traill (1994) notes that voidng is present in more rapid speech styles.

The puzzle of what goes on in the silent 250 ms after the click has now been explained by Traill (1991). He has shown that the velum is lowered so that the pressure behind the velar closure can be vented through the nose. But, unlike the similar Nama sound, there may be no audible voiceless velar nasal because there is no egressive airflow. Instead of a passive venting of the pressure behind the velar closure, there is an active pulmonic ingressive airstream mechanism, drawing air inwards. This !X66 click is probably unique among the sounds of the world's languages in that, even in the middle of a sentence, it may have ingressive pulmonic airflow. (It has been claimed by Fuller (1990) that ingressive pulmonic phones occur in Tsou, but this claim has been disputed by Ladefoged and Zeitoun (1993).)

Row (10) illustrates the voiceless velar affricate accompaniment. This click contrasts with the voiceless aspirated click in row (3) of figure 8.10 in that

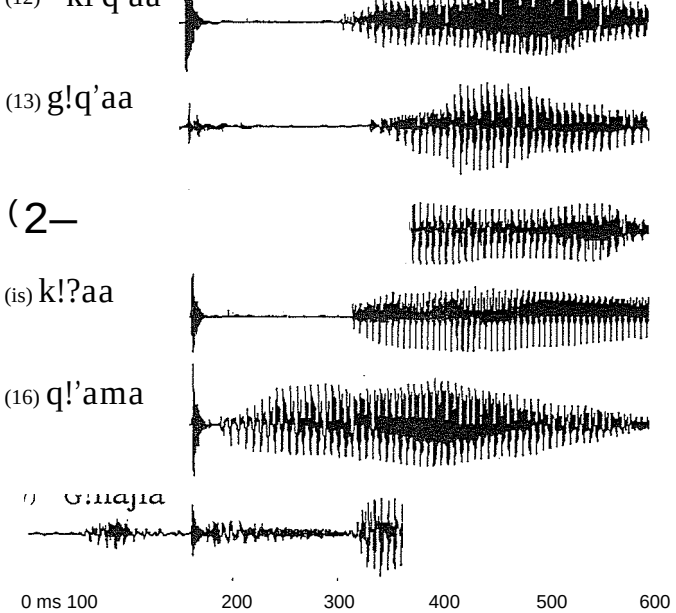


Figure 8.12 Waveforms showing the last nine alveolar clicks in !X66 in table 8.4.

the velar release is much more fricative. This can be demonstrated by data in which there are accompanying records of the pressure of the air in the pharynx, as in figures 8.13-8.18. These records were made using techniques described by Ladefoged and Traill (1984). It may be seen that in the accompaniment with a fricative constriction, the pressure behind the posterior closure may remain comparatively high for more than 140 ms after the click.

As argued by Traill (1992), the clicks in the next few rows are best regarded as sequences of consonants. The click in row (11) has voicing during the closure and for two or three periods after the release of the click. Other tokens of

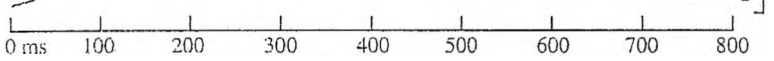
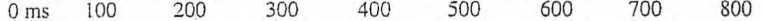


Figure 8.13 (a) Audio waveform and (b) pharyngeal pressure in a dental click with a voiceless velar affricate accompaniment.

this click are more like those in figure 8.14, which shows a dental click which can be transcribed as g | kx. Both in the dental click in figure 8.14 and in the corresponding alveolar clickg !kx in figure 8.10 there is ample evidence of friction. After the release of the click there is a considerable pressure build up duringk, followed by a fricative portion x. Clicks such as those in row (11) are sequences involving a voiced click with an accompaniment as in row (1) of figure 8.10, followed by a voiceless velar affricate. Sometimes the velar closure is not maintained after the anterior click release, and there is a click with a voiced (velar) accompaniment, followed by a voiceless velar fricative, so that the sequence is g | x rather than g | kx.

The click in row (12) is even more complex. In this particular dialect of !X6o it consists of a voiceless velar ejective released just after the release of the click, followed by the immediate formation of a uvular closure for an ejective that is released just before the vowel. This sequence can be more easily understood by reference to the dental click with the same accompaniment shown in figure 8.15. As can be seen, the pressure builds up towards the end of the closure of the click much more rapidly than seen in the previous figure. We infer that this is because the glottis is closed and the larynx is being rapidly raised. Then the releases of the anterior closure of the click and of the velar closure occur in close succession. They are followed by the immediate formation of another dorsal closure, this time at the uvular place, and a continued glottalic airstream mechanism, producing a uvular ejective.

Row (13) illustrates the voiced counterpart of this sequence. It consists of a voiced click followed by a uvular ejective. Similar articulations occur in the dental click g | q ' shown in figure 8.16. During the click closure there is very Ettle increase in pharyngeal pressure (as is normal in a voiced click), but afterwards there is a large increase in the pharyngeal pressure, which goes up to 20 cm FRO. The uvular ejective is released



Figtire 8.14 (a) Audio waveform and (b) pharyngeal pressure in a voiced dental click followed by a voiceless velar affricate.

released immediately before the onset of the vowel. The timing of the articulations of clicks of types (13) and (14) makes it quite clear that these are sequences of a voiced or a voiceless click followed by a uvular ejective rather than unitary segments. This notion is further supported by the fact that !X66 has a uvular ejective in its consonant inventory making these sequences more plausible. A similar point has been made recently by Traill (1992).

The accompaniments in both rows (12) and (13) are pronounced with more velar friction in other dialects of !X6o. Instead of the sequence of two ejectives k | 'q' illustrated in figure 8.15, there is a single ejective affricate with a less uvular quality, more appropriately transcribed as k!*'; and instead of the prevoiced version g | q', there is a sequence that could be transcribed gk!^{x}'. These more affricated dialectal pronunciations correspond to the standard pronunciation in Zhu | 'hoasi, as will be illustrated later.

Row (14) in figure 8.12 illustrates the click g !h. In this alveolar click there is voicing throughout the closure, and for a few periods after the release of the click. It is this continuation of the voicing that prevents a salient voiced velar release. Pharyngeal pressure records of a dental click of this kind are shown in figure 8.17. Again the voicing is apparent right through the closure. After the click the pharyngeal pressure drops rapidly, and there is little evidence of friction during the interval before the voicing for the vowel begins. There seems to be some variability in the way that this sound is produced. Traill (1985: 148) regarded it as a voiced click accompanied by voiceless nasal airflow, but it now appears that the oral air flow may have tire more rapid acceleration found with k | ^{h}, rather than the more slowly rising oral air flow that occurs when air is also flowing out through the nasal cavity. Traill also notes that he did not have any evidence of nasal venting. We will consider clicks of this type as generally sequences, involving a voiced click of type (1), followed by aspiration, as shown by the sequence of symbols g | and h. But on

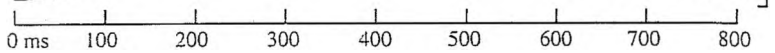


Figure S.15 (a) Audio waveform and (b) pharyngeal pressure in a voiceless dental click with an ejective accompaniment, followed by a uvular ejective.

occasions when the voicing ceases before the release of the click, the conditions will be right for a voiceless velar aspirated release, and we may regard it as a sequence of the form gk|ʰ.

Row (15) illustrates the click with an accompanying glottal stop in !Xdo. As we have seen, there is a similar click in Nama. The glottal closure is formed during the velar closure for the click, and is released considerably later. The velar release is not audible, as it occurs during the glottal closure, without any pressure build up. Our pharyngeal pressure records for both Nama and IXob show that the air pressure in the pharynx does not increase during clicks of the type shown in (15), so this is not an ejective accompaniment. As the example in figure 8.12 shows, the delay before the onset of voicing for the vowel is very similar to that in (9) with a voiceless aspirated nasal accompaniment, but the onset of the following vowel is more abrupt. The VOT is also very similar in (10), the voiceless velar affricated click, k!', in which the interval between the release of the posterior closure and the vowel is accompanied by considerable velar friction.

The click in row (16) is the uvular counterpart to (15), the voiceless velar plus glottal stop; but whereas the velar plus glottal stop does not involve an upward movement of the larynx, in the case of the uvular plus glottal stop accompaniment there is an upward movement of the larynx, making this an ejective accompaniment. As can be seen in figure 8.18, which shows a comparable dental click, the uvular plus glottal closure accompaniment has an increase in the pharyngeal pressure both during and, more sharply, after the release of the anterior click closure. There is a noticeable burst when the uvular closure is released about 15-20 ms after the release of the click, which is perceptible as a separate event. In the case of the dental click in figure 8.18, the ejective release is followed by a period of comparable length to the VOT in (15) before the glottal stop is released and voicing commences. The token illustrated in figure 8.12 has

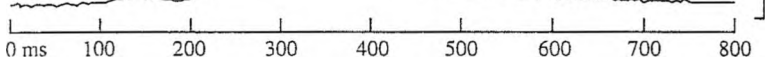


Figure 8.16 (a) Audio waveform and (b) pharyngeal pressure in a voiced dental click followed by a uvular ejective.

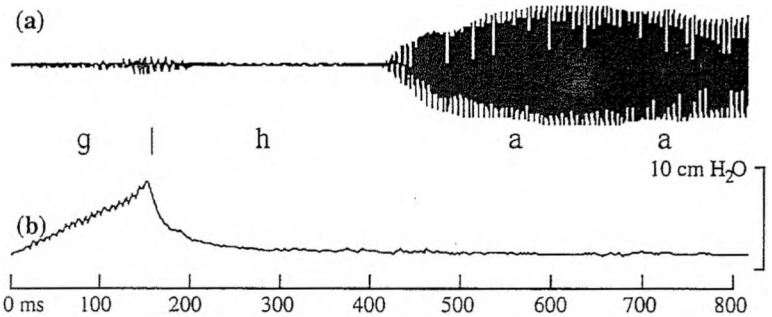


Figure 8.17 (a) Audio waveform and (b) pharyngeal pressure in a voiced dental click followed by aspiration.

a far shorter VOT.

Row (17) in table 8.4 and figure 8.12 is the uvular counterpart to (14); it consists of a voiced uvular plosive accompaniment, followed by aspiration. As can be seen in table 8.4, only three of the five clicks have been found with this possibility. As noted above, this accompaniment usually has a brief uvular nasal onset. In figure 8.12 the higher amplitude voicing seen prior to the 100 ms time marker is probably due to such a short nasal component. Lower amplitude voicing persists through the next phase of the click before the releases of the front closure and back closures in rapid succession. The release is followed by strong voiceless aspiration which may have accompanying velar friction or uvular trilling.