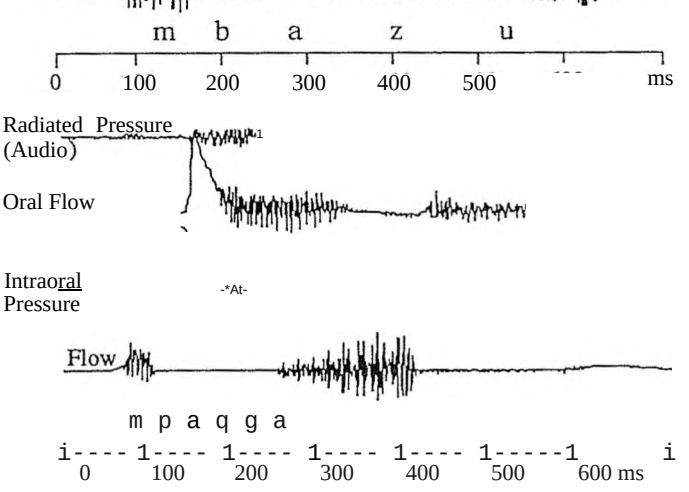

Figure 4.13 Aerodynamic records illustrating voiced and voiceless prenasalized stops in KeSukuma in the words inbazu 'goat' and mparjga 'alive (person)'.

voicing contrast (Lyman 1979). Smalley (1976) transcribes the contrast phonemically in the labial case as between /mp/ and /mph/ but gives the phonetic realization of /mp/ as [mb], and so on for other places of articulation, implying that these segments are similar to those in KeSukuma, In fact, the distinction is between voiceless aspirated and unaspirated, with the nasal portion voiced and the non-nasal portion voiceless in both cases. Spectrograms of selected tokens from a word list recorded by a speaker of the Hmong Daw (White Hmong) dialect are given in figure 4.14 to illustrate this point. An additional detail noted in this language is that the duration of the stop portion is strongly related to the place of articulation, increasing the further back the articulation is. The figure shows bilabial and uvular cases in order to indicate the range of variation observed with this speaker. With bilabials the stop closure can be extremely short, as in the examples shown, but

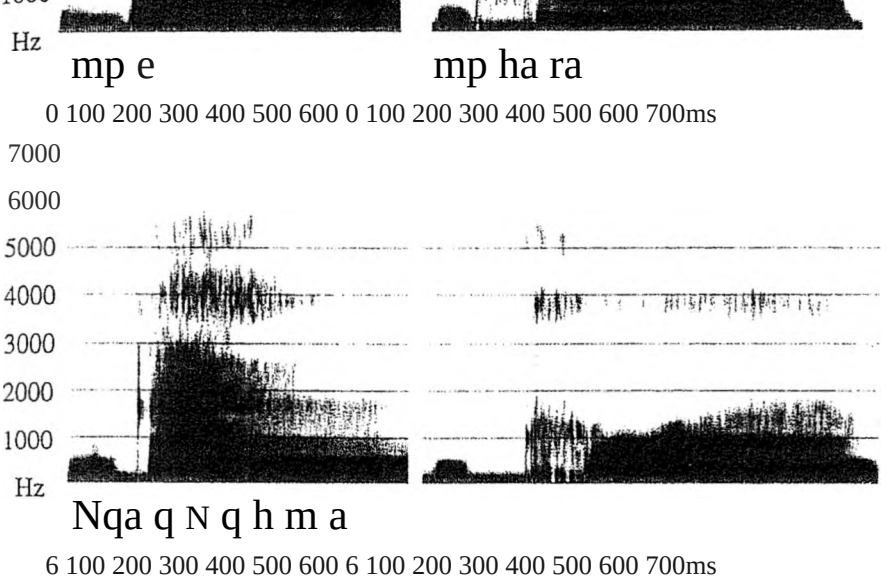

Figure 4.*14* Spectrograms illustrating voiceless unaspirated and voiceless aspirated bilabial and uvular prenasalized stops as pronounced by a female speaker of Hmong Daw. The words are mpe 'name', mphaiu 'turbulent', Nqaq 'thatch' and Nqhma 'dried up'.

uvular stop closures demonstrate maximum duration. Strong and noisy aspiration follows the release of the aspirated cases. This portion remains relatively similar in duration across differences in place.

On the other hand, voicing assimilation is not unusual in clusters; and some languages do have voicing assimilation in nasal + stop sequences under some conditions. Thus, in Bura, utterance-initial nasals preceding stops share the voicing category of the stop that follows them. This occurs in both homorganic and heterorganic nasal + stop sequences. Spectrograms exemplifying the three-way phonetic contrast of nd, nt, mt, are shown in figure 4.15. When these

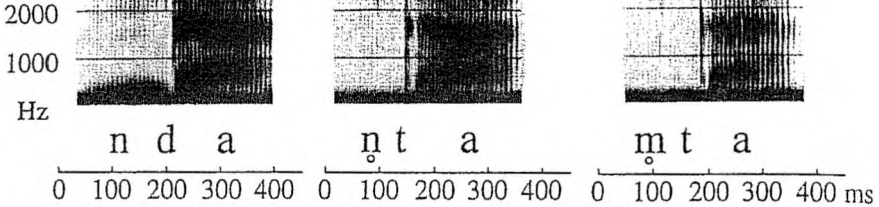

Figure 4.15 Spectrograms illustrating voicing assimilation in homorganic and heterorganic nasal + stop sequences in Bura in the words /nda/ 'cook', /nta/ 'tear (vb.)', /rnta/ 'death'.

devoiced nasals are preceded by a voiced segment in context they are voiced, and there is no reason to assume that Bura has underlying voiceless nasals (Maddieson 1983).

Devoicing of nasals before voiceless stops also occurs in a number of Bantu languages in southwestern and northeastern parts of Africa, such as Ndongo and Kwambi (Baucom 1974) and Pokomo, Pare, Shambaa and Bondei (Hinnebusch 1975). We have heard examples from Bondei and note that the phenomenon is different from that in Bura. Bura has a completely open glottis and a high volume of airflow in its voiceless preconsonantal nasals so that they sound similar to the voiceless nasals in Burmese. In Bondei there seems to be a less forceful airflow and the vocal cords, though apart, are vibrating weakly. The result is that a very low amplitude periodic component can be observed for all or part of the duration of the nasal. This phenomenon can be shown more clearly in a waveform display, as in figure 4.16, than in a spectrogram. In this token the nasal is acoustically noisy throughout, but at its beginning and end a weak periodic wave can be observed, indicating vocal cord vibration. The differences between Bura and Bondei suggest that the manner of the voicing assimilation cannot be quite the same in these two languages. In Bondei, unlike in Bura, the stop releases are aspirated. This fact is perhaps related to the differences in the devoicing process, in that the peak of the glottal opening gesture is presumably later in relation to formation of the oral closure in Bondei than in Bura.

The Bondei pattern is related to the breathy voiced nasals of Kwanyama and KeSukuma discussed earlier. In these languages, the oral stop portion of a

stop in the Bondei word ntaa 'tilapia fish'.

voiceless prenasalized stop has been lost and what remains is a nasal on which a glottal opening gesture is overlaid.

Whatever the facts concerning articulatory timing and voicing may be in a given case, the motivation for talking of prenasalized stops, rather than of a nasal + stop sequence, is often phonological rather than phonetic (in languages which do not have a within-language contrast of the type found in Sinhala and Fula). A unitary' analysis may be preferred because the language has no other consonant sequences in any position, as in Fijian (Milner 1956), or has no other consonant sequences in initial position, as in Gbeya (Samarin 1966). We note that the unitary analysis also avoids recognizing a syllable onset with the structure nasal + stop. Syllable onsets with this structure violate the expectation that more sonorous elements (in this case nasals) appear closer to the syllable nucleus than less sonorous ones (stops), in conformity with well-established ideas of the sonority hierarchy (cf. Jespersen 1897-9, Hooper 1976, Steriade 1982). In fact, violations of this particular kind seem to be rather prevalent.

A further question on prenasalization concerns whether any distinction is implied by the use of both transcriptions like [^{m}b, ^{n}d] and like [m^{b}, n^{d}], which have sometimes been distinguished as 'prenasalized stops' versus 'poststopped nasals'. The latter were noted by Y. R. Chao in Zhongshan (Chao 1948) and Taishan (Chao 1951), two Yue dialects of Chinese. More recently, Chan (1980) explicitly distinguishes between the two possibilities in her account of Zhongshan phonology. The basis for the proposed distinction lies in the perception that sometimes the nasal and sometimes the stop portion is more prominent. We do not know if this reflects a difference in relative durations of the components, or a difference in the amplitude of the burst for the stop in one case as opposed to the other. Historically, the Chinese poststopped nasals derive from simple nasals, in whose production, as Chao comments "the nasal cavity closed too early and the oral cavity opened too late" in the transition from the nasal to the following vowel. Given this historical

prestopped nasal or a nasally released stop. We do not know of a language in which it has been proposed that these two types of elements contrast, but the phonological patterns suggest that different analyses are appropriate in different cases. In some languages a syllable-initial homorganic sequence of a stop and a nasal is quite uncontroversially treated as a sequence of two separate segments. Russian is one such language. In Russian, many different syllable-initial consonant sequences occur, and stop + nasal sequences are just one of the possible types. Moreover, many of the words with initial stop + nasal sequences appear in paradigms which also include forms that have a vowel separating the stop from the nasal. Some examples are given in table 4.10. From these considerations, the separate status of the nasal and stop elements is clear.

Elsewhere, particularly in Australia, languages have been described as having 'prestopped nasal' segments. In the case of the Australian languages there is often a close connection between a simple nasal and a stop + nasal sequence. In Diyari (Austin 1981), intervocalic apical alveolar and laminal dental nasals following primary stress may optionally alternate with a stop + nasal sequence, provided that the initial consonant is not a nasal. In other positions simple nasals occur. In Arabana and Wangganuru (Hercus 1973) there is a similar, but apparently not optional, rule that also applies to bilabial nasals. Finally in Olgolo (Dixon 1970, 1980), because the initial consonants which controlled the distribution have been dropped, simple nasal and stop + nasal are in contrast in intervocalic position. A similar process has occurred in Arrernte (Dixon 1980). In this language initial vowels have also been dropped, so that

Table 4.10 Partial paradigms of Russian nouns with stop + nasal sequences ('palatalized' stops and nasals are represented as laminal post-alveolars, transcribed as d, p)

	'bottom'	'day'
NOM. SG.	dno	den
GEN. SG.	dna	dna
NOM. PL.	donja	dni
GEN. PL.	donjev	dnej

the prestopped nasals may occur in word-initial position. None of the unambiguous consonant sequences of the language are permitted in this position. Examples of Eastern Arrernte words with pre- and post-nasalized stops are given in table 4.11. Nothing in the descriptions of these languages suggests to us that there is anything phonetically remarkable about the 'prestopped nasals' in these languages, or that they are different in kind from the sequences that occur in Russian. The phonetic problem is again one of stating the timing relationship between oral and velic articulations, and relating the phonetic facts to appropriate phonological structures.

Both phonetically prestopped nasals and post-nasalized stops occur in Eastern Arrernte. The prestopped nasals are variants of plain nasals and are voiced throughout; they are illustrated in chapter 7 in figure 7.23. The post-nasalized stops, exemplified in table 4.11, have a voiceless stop release.

Another instance in which nasal release occurs is in some of the languages which are usually described as having unreleased final stops. A good example is Vietnamese. In this language word-final stops are usually released, but the release is by lowering the velum while the oral closure is maintained, so that a short voiceless nasal is produced.

Prenasalization and trills

Some other sounds combine prenasalization and trilling. Trills are primarily discussed in chapter 7, but we will briefly consider here the occurrence of prenasalized stops with a trilled release. The known types are of two sorts, bilabial and apical (alveolar or post-alveolar in place). Both occur in certain languages spoken in the Admiralty Islands north of the New Guinea mainland (Ladefoged, Cochran and Disner 1977). Kele examples are given in table 4.12. Words containing prenasalized bilabial and alveolar stops with trilled release are illustrated in the spectrograms in figure 4.17.

There are some salient differences in the roles that these two sorts of trills usually play in the phonology of the languages concerned. Whereas apical trills in general are common sounds and the prenasalized ones are not limited to

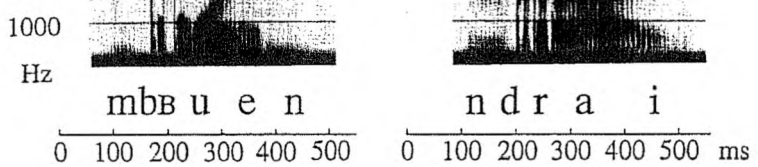

Figure4.17 Spectrograms illustrating contrasting prenasalized alveolar and bilabial stops with trilled release in Kele in the words ndrai '(your) blood' and mbuuen 'its fruit'.

Table 4.12. Words illustrating bilabial and alveolar prenasalized stops with trilled release in Kele.

PRENASAUZED BILABIAL		PRENASALIZED ALVEOLAR		ALVEOLAR	
mbsuen	'it's fruit*	ndrikei	'leg'	riuriu	sp. of insect
mbBuIei	'greens'	ndruin	'his/her bone'	raman	'red'
mbBuin	'her vagina'	ndrilei)	'song'	rarai	sp. fish

particular vowel contexts, the prenasalized instances are virtually the only occurrence of any bilabial trills in the world's languages, and are usually still limited in their occurrence to the narrow set of environments in which they developed (Maddieson 1989b, Demolin 1988). Apart from a few exceptions which remain unexplained in Nias (Catford 1988b), and the special case of Luquan Yi fricative vowels (see chapter 9), all bilabial trills historically developed from a sequence of a prenasalized bilabial stop followed by a relatively high back rounded vowel, i.e. a sequence such as mbu. These segments remain prenasalized and contain a short oral stop phase which is released into a trill that occupies much of the anticipated duration of the following vowel. In languages such as Na?ahai, where the trilled release is in complementary distribution with a simple prenasalized bilabial stop, the bilabial trill articulation is equally open to being regarded as a modification of u that occurs after a prenasalized bilabial stop as to being regarded as a modification of mb that occurs before u.

Table 4.13 shows the results of measurements on prenasalized bilabial stops with trilled release in three Austronesian languages and the Camerounian language Nweh. The duration of the oral stop closure before the trill is exactly comparable to that in prenasalized voiced stops in other languages, where it is

Nweh (n = 15)	33.1 ms	44.1 ms	23.1 Hz
s.d.	*8.12*	3.73	2.1
Mean across languages	32.85	41.15	24.8

usually on the order of 30 ms. The closure period in the trill is considerably shorter, resulting in the duration of the period from the release of one closure of the trill to the release of the next being only a little longer than the stop closure. Most interestingly, the rate of trill vibration for the lips is only slightly slower than that observed in apical trills despite the larger mass of the lips. This point will be taken up in chapter 7.

The use of a trill as a modification of the release of a coronal stop occurs in a number of languages. Stops of this kind are reported in Austronesian languages such as Malagasy (Dyen 1971), Fijian (Milner 1956) and several of the Admiralty Islands languages in addition to Kele. The Fijian case is reportedly a trill following a voiced prenasalized post-alveolar stop. But in a study of 11 speakers of Fijian, Maddieson (1991) observed that trilling was in fact very rare at the release of this stop. The major distinguishing characteristic is rather that the place of articulation is postalveolar.

4.4 Nasalized Consonants

There are two major types of nasalized consonants. One type is a nasalized click. Since the click-producing mechanism of the velaric airstream operates in front of the velic opening, pulmonic air may quite freely pass through the nasal passage simultaneously with the production of a click, resulting in a nasalized click. A variety of different laryngeal settings may also be employed, so that this nasal accompaniment to the click can be voiced, voiceless, breathy, and so on. A separate chapter is devoted to clicks, and these nasalized clicks will be discussed there.

often as allophonic variants of their non-nasalized counterparts in positions where nasality spreads from a nasal consonant or a nasalized vowel in the neighbourhood. The segments said to be involved are usually voiced. For example, standard accounts and our own observations of Yoruba agree that the voiced approximants w and j are nasalized when they precede a nasalized vowel. In some languages a nasal segment can be accompanied by anticipatory nasalization, potentially of several preceding syllables, as occurs in Guarani (Gregores and Suarez 1967, Lunt 1973). (Guarani also has been variously analyzed as having inherently nasalized morphemes or a set of nasalized vowels, and nasalization also spreads from these. The facts are phonologically complex and a full presentation will not be attempted here). In the course of this spreading of nasalization, nasalized voiced continuants and approximants are phonetically derived. Gregores and Suarez note that the nasalized counterparts of the voiced fricatives v and y are the voiced approximants u and iq.

Languages clearly differ in the degree to which nasalization spreads to and through adjacent segments and the direction of the spread, and hence in the number and kind of surface nasalized segments that occur, as has been shown by Cohn (1990, 1993). The acoustic consequences of a lowered velum are also not uniform for segments of different types. There is very little auditory difference between nasalized and non-nasalized voiceless fricatives and approximants; and it seems likely that articulatory assimilation of voiceless sounds to adjacent nasal or nasalized segments is more common than is usually reported. We believe that in Yoruba, for example, the voiceless approximant h is usually also nasalized before a nasalized vowel, although this is not noted in descriptions of the language. Nasalization of h is clearly demonstrated in Central Igbo in a kymogram tracing published by Carnochan (1948), and in Sundanese in data published by Cohn (1993). We are less sure that the nasalized voiced and voiceless labiodental and alveolar fricatives reported for Igbo by Green and Igwe (1963) actually have simultaneous nasal airflow, rather than being elements that occur with nasalization of the following vowel - the device of marking the consonants as nasalized being employed, as noted by Williamson (1969), to identify the limited set of consonants that can begin syllables with nasalized vowels.

However, nasalized voiceless approximants do occur contrastively in some

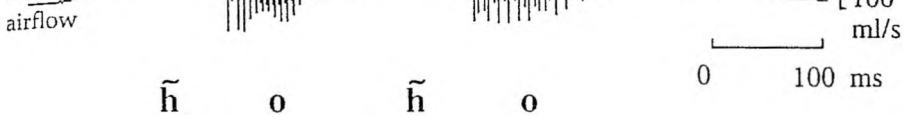

Figure 4.IS Aerodynamic records of voiceless glottal fricatives in the Kwangali word hoho *nhonho* 'devil's thorn'.

Southern Bantu languages. Both Kwangali and ThiMbukushu, two Kavango languages spoken in northern Namibia, have clear contrasts between h and h. Near-minimal pairs from Kwangali are shown in table 4.14. Aerodynamic data for the first word in table 4.14 are shown in figure 4.18. During the initial and the intervocalic consonant there is both oral and nasal airflow. In both cases the peak velocity in the nasal airflow is greater than that in the oral airflow. It is also evident that there is a great deal of nasal airflow throughout both vowels. These vowels are both phonologically o (there are no contrastively nasalized vowels in this language), but they are phonetically 6. In all the words containing h that we recorded it was clear that the following vowel was also nasalized. The nasalization might therefore be thought of as a property of the syllable as a whole, much as it might be in Yoruba. But in Yoruba nasalized vowels contrast with oral vowels after oral consonants and nasalized semivowels occur only before nasalized vowels. In Kwangali there are no phonologically nasalized vowels; these vowels occur only in the context of nasals and nasalized consonants, which must include h.

Nasalized continuants have been claimed to be contrastive segments in a number of languages apart from Igbo. Boyeldieu (1985) argues for interpreting was a phoneme in Lua. Stringer and Hotz (1973) describe Waffa as having a nasalized voiced bilabial fricative p. This segment contrasts with p, m and the sequence mb (treated as a single unit by Stringer and Hotz). Examples illustrating these sounds in Waffa, taken from Stringer and Hotz's work, are given in table 4.15. Stringer and Hotz do not comment on vowel nasalization, but they do not report nasalized vowels to be phonemic in Waffa.

Ohala (1975) offers persuasive reasons for believing that voiced nasalized