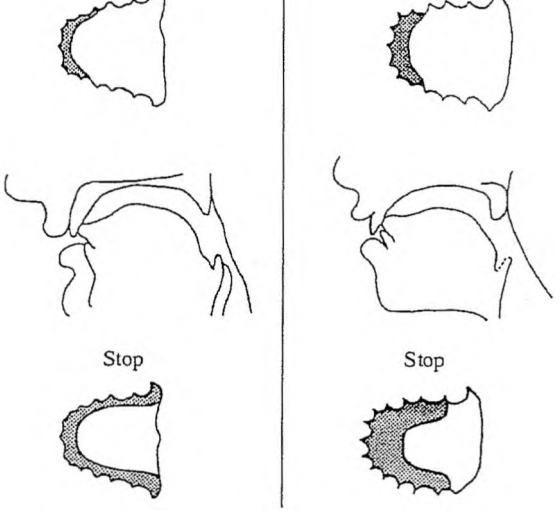

Figure 6.2 X-ray tracings and palatograms comparing articulatory positions for 1 and t in German and Standard Chinese (based on data in Wangler 1961, and Zhou and Wu 1963 respectively).

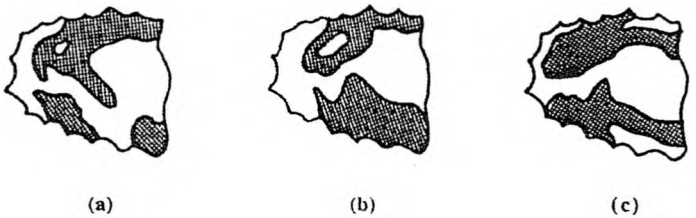

Figure 6.2 Palatograms showing contact area for three repetitions of 1 by a Gonja speaker (based on data in Painter 1970).

they have a larger escape channel further back in the mouth. Note that these laterals with no central closure are in syllable-initial positions, not in final position. We will return to the question of laterals without a central closure below, in connection with the vocalization of postvocalic laterals.

First let us review what articulatory gestures are used in the production of laterals of the common voiced approximant type. We will do this by reference to the point of most forward contact of the tongue (the traditional place of articulation) and to the part of the tongue that is involved. We will also discuss some questions concerning the shape of the remainder of the tongue where this is known. As in previous chapters, we will begin by examining the differences between typical productions of contrasting lateral segments within a language and then building a composite picture of the range of contrasts that seems possible. The terminology for places of articulation will be that developed in earlier chapters.

There are fewer places at which laterals are produced and fewer contrasts between laterals than is the case with stops or fricatives. The largest number of contrasting simple voiced lateral approximants known to occur in a language is four, as found in our own work on Kaititj (see below) and reported from several other Australian languages such as Pitta-Pitta (Blake 1979), Diyari (Austin 1981) and Arabana (Hercus 1973). Kaititj has laminal dental, apical alveolar, apical post-alveolar and laminal post-alveolar laterals. Examples of words containing these are given in table 6.1.

The number of languages which contrast simple voiced lateral approximants at three places of articulation is also relatively small, and many of these are also languages of Australia. Examples are Nunggubuyu, Alawa and Bardi.

Table 6.1 Words illustrating contrasting laterals in Kaititj

	LAMINAL DENTAL	APICAL ALVEOLAR	APICAL POST-ALVEOLAR	LAMINAL POST-ALVEOLAR
	111			1
INITIAL	linp 'armpit'	1 ubu 'thigh'	lajirjk 'hit'	lukurjk 'light (fire)'
MEDIAL	alurj 'burrow'	al urik 'chase'	alat 'sacred board'	alilk 'smooth'
FINAL	albal 'smoke'	irmal 'fire saw'	aldimal 'west'	kural 'star'

Figure 6.3 Cine x-rays of apical dental and apical alveolar laterals in Albanian: 1 in hala 'aunt', 1 in pala 'pair' (based on data in Bothorel 1969-70).

These languages lack the laminal post-alveolar lateral found in languages like Pitta-Pitta. The Papuan language Mid-Waghi, which will be discussed below, also has three places for laterals, as do a number of languages from other parts of the world, including Khanty (Gulya 1966) and Argentinian dialects of Mapuche (Key 1978). Languages with two laterals are much more frequently encountered; detailed articulatory phonetic information is available on some of these languages. Several of these throw interesting light on the role of tongue profile in contrasting articulatory gestures.

Cine x-ray studies (Bothorel 1969-70) indicate that Albanian has a distinction between what might be labeled apical dental and apical alveolar laterals. Tracings of these are given in figure 6.3. Note that besides the different location of the 'place of articulation' there are several other differences between 1 in *pala* and 1 in *halla* in this figure. The back of the tongue is retracted for I so that a narrowed pharynx results, and the body of the tongue lies lower in the mouth than for 1. The speaker represented in Dodi (1970) seems to have less of a place difference than the two speakers examined by Bothorel, but does show the difference in tongue profile. The Albanian laterals indicate that the dental vs alveolar place contrast can occur with the 'enhancement' of different tongue body positions but without differing by one being laminal and the other apical.

Laminal post-alveolar (palato-alveolar) laterals occur in limited surface contrast with apical alveolar laterals in the dialect of Breton spoken at Argol (Bothorel 1982). Cine x-rays of these sounds are shown in figure 6.4. The particular token of the apical lateral shown in this figure has a somewhat more forward position than those before other vowels, and the tongue partly contacts the teeth. It was selected in order to show the two contrasting laterals of the language in similar vowel environments. The laininal post-alveolars occur only after an actual or historical i and consequently have some similarities of tongue position to the high front tongue position for i. However, they cannot

Argol dialect: I in sala:n 'salads', j in butaladu 'bottles' (based on data in Bothorel 1982).

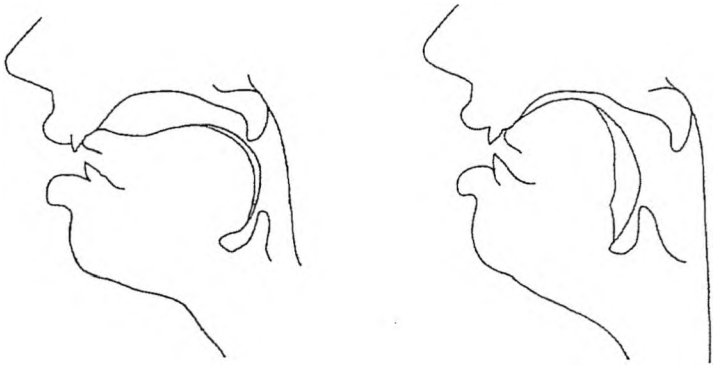

Figure 6.5 Cine x-rays of apical alveolar and laminal alveolar laterals in Russian: lak 'varnish', lina 'line' (based on data in Koneczna and Zawadowski 1956). The laminal articulation is the phonologically palatalized counterpart of the apical lateral.

be regarded as simply the result of coarticulation, since they do not necessarily occur next to an actual i vowel, as the example we have chosen shows.

The Breton laminal post-alveolar lateral tongue shape is in some respects quite similar to that seen in cine x-rays of the Russian 'soft T (Koneczna and Zawadowski 1956, Fant 1960, Jazic 1977, Bolla 1981,1982), although in the Russian sound the contact is further forward. This Russian laminal lateral is commonly referred to as a palatalized version of the apical 'hard 1', but as the example in figure 6.5 shows, for many speakers the primary articulation itself differs from that seen in the non-palatalized counterpart. For some speakers of Russian, the contrast can be described as between an apical and a laminal alveolar. For others, the contrast is between an apical alveolar and a laminal dental. In addition, there are differences in the position of the body of the tongue. The apical lateral in figure 6.5 has some raising of the back of the tongue and considerable narrowing of the pharynx. For the laminal lateral in figure 6.5 the

well as the verbal descriptions by Stojkov, make it clear that Bulgarian 1 is a laminal dental. Except before front vowels, the front of the tongue is low behind the occlusion and the back of the tongue is raised toward the velum. Its palatalized counterpart is laminal post-alveolar (palato-alveolar), and the body of the tongue is generally higher in the mouth, particularly in the front (although it seems less high than in the Breton case cited above).

The x-ray study by Jazic (1977) contrasts Russian and Serbo-Croatian i's and their palatalized counterparts. For Serbo-Croatian P the occlusion is palato-alveolar, with the tongue body high and the pharynx wide. Serbo-Croatian I has a low tongue profile but still a relatively wide pharynx, similar to that seen in the German and Breton x-rays in figures 6.1 and 6.4. Thus, phonological palatalization is not always accompanied by a big difference in pharynx width.

The extent to which different tongue profiles of the types seen in the contrasting laterals of Albanian, Breton, Russian, Bulgarian and Serbo-Croatian can be chosen independently of the tongue tip and blade activity is unclear. It seems reasonable to suppose that the choice of laminal or apical articulation i restricts the freedom of position for the tongue body to some degree, and that raising the front of the tongue favors laminal articulation, whereas lowering it favors apical articulation. The data we have seen suggests that wide pharynx and raised tongue front usually accompany the laminal articulations, but the Bulgarian data shows that this is not invariably the case. The tongue profile may be more variable when the articulation is apical, but raising of the back of the tongue and/or narrowing of the pharynx are not uncommon. But there is unfortunately too little data available from too few languages to be sure how generally these observations apply. It would be nice to know, for example, if the tongue profile differences in Russian laterals are replicated in Diegueno (Langdon 1970). This is also a language with laterals with two types of articulation, in one of which "the apex [of the tongue] is raised to touch the alveolar ridge" while in the other "it is lowered to touch the back of the lower teeth with the blade contacting the alveolar ridge." However, Diegueno lacks the general phonological division of consonants into plain and palatalized classes which characterizes Russian and several of the other languages we have discussed here. We do not know if laminal alveolar or post-alveolar laterals occur without an accompanying raising of the tongue front which might be characterized as some form of 'palatalization'. Our examination of spectrograms of the

Figure 6.6 Palatograms of apical alveolar and laminal palatal laterals in Spanish, Standard Peninsular Castilian dialect (after Navarro Tomas 1968).

Diegueno laminal lateral suggest that it is a palato-alveolar articulation, with a raised tongue position.

The pre-palatal laminal laterals we have been discussing so far can be distinguished from dorsal palatal laterals. Laterals of the latter type are found in Italian in contrast with apical alveolars, as well as in Spanish and a number of other languages. In these palatal laterals, contact is made between the tongue dorsum and the hard palate. Bladon and Carbonaro (1978) show the occlusion for Italian X being made about two-thirds of the way back on the hard palate. In those dialects of Spanish which have a palatal lateral (principally those of European Spanish), the articulation seems to be a little further forward. The contact area is quite extended, as may be seen in figure 6.6 based on palatograms of Spanish 1 and X in Navarro Tomas (1968). A tracing of an x-ray of Spanish X in Straka (1965) shows the tongue tip not making any contact with the teeth (as in the palatogram in figure 6.6), whereas one in Quilis (1963) shows an extension of the contact area all the way from the palate to the teeth.

Contrasts involving sublaminal post-alveolar (retroflex) laterals appear in Tamil, Malayalam, Toda and other Dravidian languages in which stops at this place of articulation occur. Most Dravidian languages have only two places of articulation for laterals, instead of the six or seven places they have for stops. Svarny and Zvelebil (1955) publish palatograms and x-rays documenting the fact that Tamil and Telugu contrast apical alveolar and sub-apical retroflex laterals, with a tongue shape for the retroflex lateral very similar to that for the corresponding stops shown previously in figure 2.7. The contact for the retroflex lateral is on the hard palate, hence these sounds could be considered as produced with the 'apical' variety of the palatal place of articulation. Outside the Dravidian language family contrastive sub-apical retroflex laterals are not known for certain to occur, but, to judge from a sketch of the articulators in Gulya (1966), this type of retroflex lateral may occur in Khanty, in contrast

whereas those of the Indic languages with retroflex laterals, such as Panjabi, are apical post-alveolars.

It used to be said that only coronal sounds could be lateral (Chomsky and Halle 1968), or that laterals occurred only at the dental, alveolar, retroflex and palatal places of articulation (Ladefoged 1971). However, velar laterals also occur contrastively. Velar laterals, not always of the voiced approximant type, appear in Melpa and Mid-Waghi in contrast with laterals at other places of articulation (Ladefoged, Cochran and Disner 1977), and in Kanite (Young 1962) and Yagaria (Renck 1975) as the only lateral segments. These are all languages of New Guinea, but velar laterals are reported also in Kotoko and possibly also occur in other East Chadic languages (Paul Newman, personal communication) and Hagege (1981) reports a voiced velar lateral in Comox. Words illustrating the three contrasting laterals which appear in Mid-Waghi, laminal dental, apical alveolar and (dorsal) velar, are shown in table 6.2. The acoustic character of these examples is discussed below.

The precise location of the contact and of the lateral escape channel for the velar cannot be recorded by direct palatography since the closure is too far back, but with an open vowel before and after a velar lateral it is possible to see both the central velar closure and the lateral opening simply by looking into the speaker's mouth. For the Mid-Waghi speakers we recorded, it was possible to see that the tongue was bunched up in the back of the mouth with the tip retracted from the lower front teeth. The body of the tongue was visibly narrowed in the central region, and presumably also further back where it could not be seen. The only articulatory contact was in the back of the velar region in much the same position as for a velar stop and, according to the speaker, air escaped around both sides of this contact in the region of the back molars. In addition, the auditory impression created by the brief stop closure which sometimes occurs before the lateral is clearly velar. In his account of Comox, Hagege (1981) gives a similar description of this sound. He notes that the back of the tongue makes quite firm contact with the back of the velum and the sides of the tongue are lowered so that there is only weak friction and the sound is an approximant.

Trager and Smith (1956) claim that velar laterals also occur in certain varieties of American and Scottish English, but no other observers have agreed with

this claim. It seems likely that they were referring to what we would call velarized alveolar laterals, or possibly to laterals without a central occlusion which we will discuss later.

Production of uvular or epiglottal (pharyngeal) laterals by narrowing the tongue and using a medial occlusion formed with the uvula or the epiglottis respectively is not inconceivable; however, no such sounds are known to occur in any natural human language. Bilabial and labiodental approximants can be produced with a central occlusion and lateral airflow, but these seem to be indistinguishable from the corresponding central approximants. (In fact, for many English speakers the labiodental fricatives f and v are produced as what might by some definitions be lateral segments, since they have a closure in the midline.) Note that since we define laterals as involving narrowing of the tongue, these labial articulations are not laterals by our definition. On the other hand, laterals can be produced by an articulation involving the tongue and the upper lip. Linguo-labial laterals sound quite distinctive, but none of the languages that have developed this place of articulation (illustrated for stops and fricatives in chapter 2) has employed it in the production of lateral segments as far as we know.

We therefore have indications that there are nine 'places of articulation' used for lateral approximants, as summarized in table 6.3. Of these nine places, eight participate in pairs that can be distinguished by the apical/laminal feature operating independently of other aspects of the place feature system, as described in chapter 2. Distributional facts concerning laterals in Australian languages (Dixon 1980) provide good evidence for treating the apical/laminal distinction as a separate feature. For example, in those languages with four laterals only the two apical laterals may appear as the first element of a medial consonant cluster.

Voiced approximant lateral segments seem to be prone to considerable variation in their production, both from individual to individual and from one phonetic context to another. In a palatographic and linguographic study of 20 English speakers and 21 French speakers, Dart (1991) found a wide variety of

Figure 6.7 Tracings of frames from x-ray film of 1 + 3 in the phrase *belles jambes* spoken by a speaker of French (based on data in Rochette 1973). The speaker was a 23-year-old male native of Paris.

articulations for 1 within the dental/alveolar region, with somewhat greater variation among English speakers than among French speakers. She also noted that there is a strong tendency for 1 to be apical. Even in French, in which t, d, n are usually laminal dental, about 85 percent of the speakers produced 1 as an apical alveolar.

Contextual variations among laterals have been well documented in many languages. In English, for example, 1 is subject to considerable assimilatory effect from adjacent voiceless consonants (especially from preceding stops), considerable coarticulatory effect of adjacent vowels, and considerable variation attributable to effects of position in the syllable and morpheme (Lehiste 1964, Giles and Moll 1975, Bladon and Al-Bamemi 1976, Dent 1984, Gartenberg 1984, Sproat and Fujimura 1993). Large within-speaker variation in the articulatory position for French I in various consonant sequences are documented by Rochette (1973). These include even sublaminal palatal (retroflex) productions in the sequences 1 + 3 and 1 + f. The production of an 1 + 3 sequence is illustrated in figure 6.7. The heavy outline shows the steady state position for the 1, which is maintained for about 60 ms. The lighter traces show phases of the release, as the tongue tip is lowered towards the position for 3 and the lips are protruded in anticipation of the rounding that usually accompanies this fricative in French.

The resonant nature of laterals and their somewhat vowel-like acoustic structure seem to make coarticulated variation in their production quite noticeable, more so than might be the case with other classes of segments. The degree of variability seems to depend in part on tongue position; laterals with a high tongue body position such as palatals or laminal post-alveolars show less variation than laterals with a lower tongue body position. For example, Italian 1 shows much more variation, measured acoustically by variation in F2, with respect to both following and preceding vowel context than does X

both sides. In syllable-final /!/ there is no alveolar contact and the tongue tip may be behind the lower front teeth. But there may still be a narrowing of the tongue so that, by our definition, this segment is still a lateral. It seems as if the situation is similar in Portuguese. Feldman (1972) shows that the final allophone of /!/ in certain varieties of Brazilian Portuguese is produced with no occlusion but with a marked raising of the tip of the tongue towards the alveolar ridge, where initial allophones of /1 / would have a contact. This vestigial tongue-raising gesture, together with raising of the back of the tongue produces a segment which is acoustically very similar to o, and for some speakers of Brazilian Portuguese merges with that segment. Laterals of this type are likely to become simply vowels or semivowels with the passage of time (as they have in Polish and some forms of Southern British English), but as long as the tongue narrowing gesture remains they are still correctly classed as laterals.

6.2 Acoustic Characteristics of Voiced Lateral Approximants

Canonical voiced lateral approximants are characterized acoustically by well-defined formant-like resonances. The first formant is typically rather low in frequency. The second formant may have a center frequency anywhere within a fairly wide range depending on the location of the occlusion and the profile of the tongue. The third formant has typically a relatively strong amplitude and high frequency; and there may also be several closely spaced additional formants above the frequency of F3. When a lateral is adjacent to vowels an abrupt change in formant location can often be observed both when the medial closure for the lateral is formed and when it is released, particularly if the articulation is apical. Laminal and dorsal laterals may have somewhat slower transitions from and to adjoining vowels. These properties can be seen by examining the spectrograms in figures 6.8 (Arrernte) and 6.9 (Mid-Waghi) below.

The first formant of lateral segments is uniformly low - typically below 400