

Figure 2.3 More detailed diagrams of the anterior part of the vocal tract in figure 2.2, showing articulations involving the tongue tip and blade.

sidered to have glottal targets. Note that we use the term alveolar to denote only the front part of the alveolar ridge. This seems to be the practice of most phoneticians, although it is somewhat confusing in that it means that the point of maximum curvature in the alveolar ridge forms the boundary between what we call the alveolar as opposed to the post-alveolar region.

Most of the traditional place terms specify both the moving articulator and the articulatory target on the upper or back surface of the vocal tract. It is these pairings between active articulator and articulatory target that are indicated by the numbers on figures 2.2 and 2.3, and not specific positions. Thus 'velar' implies an action involving the body of the tongue and the velar region, and 'epiglottal' implies an action involving part of the root of the tongue (specific-

*Table 2.1.* Terminology summarizing the place of articulatory gestures

"PLACE OF ARTICULATION"	ARTICULATORY TARGET REGION	MOVING ARTICULATOR	SYMBOL EXAMPLES
1. Bilabial	Labial	Lower lip	p b m
2. Labiodental	Dental	Lower lip	cp d> H]
3. Linguo-labial	Labial	Tongue blade	t d n
4. Interdental	Dental	Tongue blade	t d n
5. Apical dental	Dental	Tongue tip	t d n
6. (Laminal) denti-alveolar	Dental and alveolar	Tongue blade	<u>t d n</u>
7. Apical alveolar	Alveolar	Tongue tip	t d n
8. Laminal alveolar	Alveolar	Tongue blade	t d n
9. Apical retroflex	Post-alveolar	Tongue tip	t d n
10. (Laminal) palato-alveolar	Post-alveolar	Tongue blade	t d n
11. Sub-apical (retroflex)	Palatal	Tongue underblade	14. n.
12. Palatal	Palatal	Front of tongue	c f P
13. Velar	Velar	Back of tongue	
14. Uvular	Uvular	Back of tongue	q G N
15. Pharyngeal	Pharyngeal	Root of tongue	h V
16. Epiglottal	Epiglottal	Epiglottis	? H S
17. Glottal	Glottal	Vocal folds	?

alveolars. Sounds in an area behind the alveolar ridge can also be made with the underside of the tip of the tongue, in which case they are called sub-apical retroflex sounds. Articulatory pairings involving the tongue tip and blade are shown in figure 2.3. Table 2.1 presents some of the terminology that is used for labeling articulatory gestures, together with examples of the symbols used for their representation.

The 17 possibilities listed in table 2.1 indicate the major movements of part of the vocal tract from a neutral position towards the center of each target. In the next section of this chapter we will show that each of these possibilities represents one of the different articulatory movements that are used in consonant gestures (all of them, with the exception of the pharyngeal articulation, being used for stop consonants). The final section will consider whether there

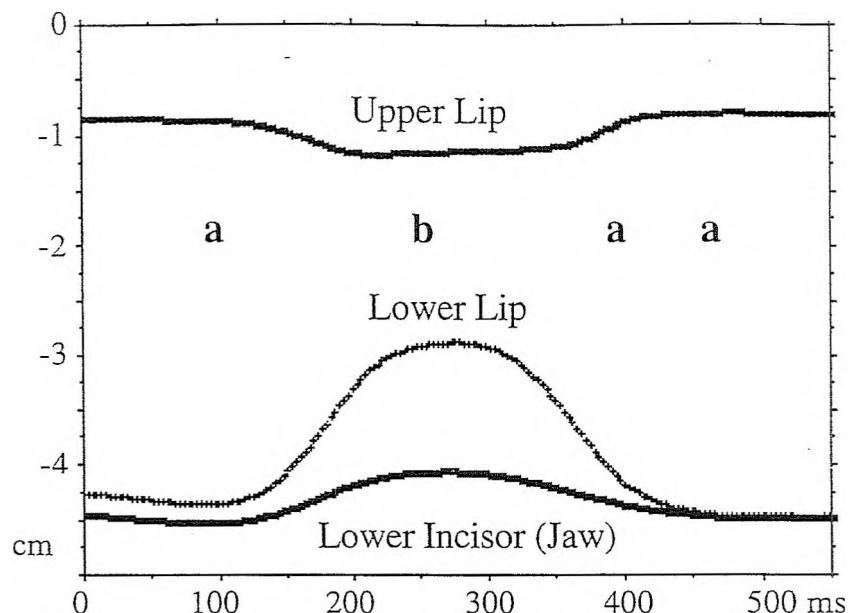


Figure 2.4 Mean vertical movement trajectories over time of the upper and lower lips and the jaw during ten repetitions of the Ewe word abaa 'mat' (from Maddieson 1993)- Electromagnetic receivers were placed on the outside surface of the lips, hence a gap remains between them even during closure.

upward-moving lower lip to form the closure and moves back up at the release. A typical movement pattern for the lips in producing a bilabial stop is shown in figure 2.4. This figure tracks the vertical position of the lips over time. Partly because both articulators are in motion, and therefore the increase in the cross-sectional area of the oral escape channel occurs more rapidly, the release phase of a bilabial stop is typically shorter than that of stops at other places of articulation. On many occasions (but not noticeably so in the stop shown in figure 2.4), aerodynamic forces may also cause the lips to separate more rapidly than they close (Fujimura 1961). The fact that both articulators are soft tissue may explain why bilabial stops are more likely to be produced with incomplete closure than stops in which the active articulator contacts a less flexible surface. This results in patterns such as that in Japanese, where in native and Sino-Japanese vocabulary /p/ is pronounced word-initially as ſ or h (depending on the following vowel), and as p in a cluster with another consonant, whereas t, k do not alternate with fricatives (McCawley 1968, Shibatani 1990: 166–7).

The use of the labiodental place of articulation is largely restricted to fricatives, so we will defer most of the discussion of that place until chapter 5. There is, however, no doubt that at least for fricatives there is a contrast between bilabial and labiodental articulations. We do not know whether true labiodental stops occur in any language, although they have been reported among languages of Southern Africa, where the symbols [cp] and [cb] have been used for their transcription since at least Doke's 1926 study of Zulu. Guthrie reports that "there is a labiodental plosive which is distinct from the bilabial plosive, e.g. -cbar- 'shine', -bar- 'give birth to'" in a language in the Nyanja-Tumbuka group that he called Tonga (Guthrie 1948: 61). We have not heard this language, and are unsure how it relates to languages with similar names in the region. In the nearby Tsonga dialects of South Africa, Baumbach (1974, 1987) reports labiodental affricates. Significantly, when an assimilated nasal occurs before these affricates Baumbach affirms that it shares the labiodental place of articulation, and therefore the labiodental friction, of the

Table 2.2 Words illustrating some of the labial consonants of the XiNkuna dialect of Tsonga (from Baumbach 1974, 1987)

	BILABIAL PLOSIVE	BILABIAL FRICATIVE	LABIODENTAL AFFRICATE	LABIODENTAL FRICATIVE
VOICELESS	papa	4>u	tinjcpfupu	njfutsu
UN ASPIRATED	'cloud'	'finished'	'hippos'	'tortoise'
VOICELESS	p <sup>h</sup> ap <sup>h</sup> atani		irjcpf <sup>l</sup> 'uka	
ASPIRATED	'butterfly'		'distance'	
VOICED	kuba	kupapa	Jilecbvu	kuvumba
	'to hit'	'to be painful'	'chin'	'to guess'
BREATHY	jimb <sup>B</sup> o		njd>v <sup>h</sup> upu	kuv <sup>f</sup> eta
VOICED	'ostrich'		'tree (sp.)'	'to scratch'

Labioidental nasals occur in many languages. As in Tsonga they are usually the result of coarticulation with a following labiodental fricative. The Yoruba word rrife 'want, like (imperfective)' is formed by preposing an imperfective marker consisting of a syllabic nasal with no inherent place to the verb stem fe. Labiodental nasals have, however, been reported as segments contrasting with both bilabial nasals and labiodental fricatives in the Kukuya dialect of Teke. Paulian (1975) describes these sounds as "realized as a labiodental nasal occlusive, invariably voiced; the occlusion is formed between the upper teeth and the lower lip, and is accompanied by strong protrusion of both lips." (our translation) We do not know if a true occlusive could be made with this gesture, when we take into account the gaps that often occur between the incisors.

The third known possibility for an articulation concerning the Labial region involves moving the tongue forward to contact the upper lip. A series of linguo-labial segments has developed in a group of languages from the islands of Espiritu Santo and Malekula in Vanuatu (Maddieson 1989a). These lan-

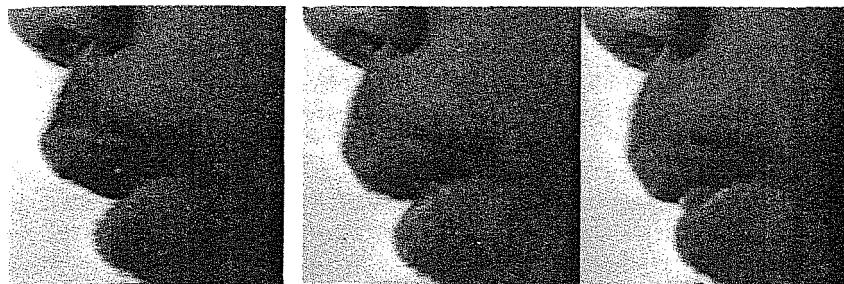


Figure 2.5 Three frames from a videotape showing the tongue and lip contact in the production of the 'word nandak 'bow<sup>7</sup> by a speaker of Vao.

Table 2.3 Words illustrating bilabial, linguo-labial and alveolar places of articulation in Tangoa (from Maddieson 1989, Camden 1979)

	BILABIAL		LINGUO-LABIAL		ALVEOLAR	
PLOSIVE	peta	'taro'	tete	'butterfly'	tana	'father'
NASAL	mata	'snake'	nata	'eye'	nunua	'messenger spirit'
FRICATIVE	piliu	'dog'	3atu	'stone'	sasati	'bad'

speaker of Vao. The first frame shows the starting position of the upper lip, as the tongue begins its forward movement. The second frame, 60 ms later, shows a downward and backward motion of the upper lip toward the advancing tongue. The third frame, another 60 ms later, illustrates the culminating phase of the articulation, with a complete occlusion formed between upper lip and tongue blade.

An even more unusual sound occurs in Piraha, a Mura language spoken by

articulations in which the tongue tip or blade makes the constriction. If the group is defined by the use of the tongue tip or blade as the active articulator, then linguo-labials and at least some articulations in the palatal region will be included. Again, we will discuss the linguistic merits of different groupings in the final section of this chapter.

Apart from labiodentals, articulations in the dental region can be made only with the tongue tip or blade as the active articulator. The tongue more commonly contacts the back of the teeth, but the tip may also project between the teeth so that the blade makes contact with the underside of the upper teeth. The special term for this articulation is interdental. We have included a distinction between dental and interdental places of articulation in table 2.1 and figure 2.2, but we do not know of any use of this distinction to form phonemic contrasts. It seems that some languages may consistently use one or the other possibility while others permit the use of either of them. As we will discuss in chapter 5, speakers of American English from California typically use an interdental fricative in words such as 'think', but nearly all speakers of British English use a dental fricative in such words. A similar variation between dental and interdentals is apparent when we examine Australian languages. Dixon (1980) notes that Australian languages often have interdental stops in which the "teeth are slightly apart, and the blade of the tongue projects between and touches both sets of teeth," whereas Butcher (in progress) notes that both postdental and interdental articulations occur among speakers of the same language. In postdental stops the tip of the tongue may be turned down so that it touches the back of the lower teeth, while a closure is formed by the tongue blade contacting the upper teeth.

A difference between apical dental and interdental gestures with different manners of articulation occurs in Malayalam. Some of the speakers we investigated used an interdental nasal n in words such as punni 'pig', but they made t as a dental stop without tongue protrusion in words such as kutti 'stabbed'. This may be related to the fact that Malayalam has a contrast between dentals and alveolars for both stops and nasals. Acoustically, both dental and interdental stops are quite distinct from the contrasting alveolar stops in their

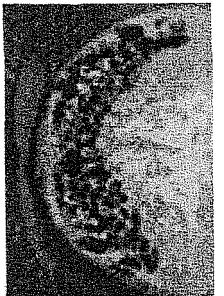
*Table 2.4* Words illustrating dental, alveolar and sub-apical retroflex stops in syllable final position in Toda

	VOICELESS		VOICED	
DENTAL	pot	'ten'	mod	'churningstick' ·
ALVEOLAR	pa:t	'cockroach'	mod	'village with dairy'
RETROFLEX	tat	'churning vessel'	matt	'head'

rather than apical, with contact on both the teeth and the front part of the alveolar ridge, whereas the alveolar stops are often apical, with contact usually on the center of the alveolar ridge. This is the pattern in widely dispersed languages such as Malayalam, Tiwi, Ewe, and Dahalo. In many languages (including all those just mentioned) the dental stops typically have a long contact region in the sagittal plane, and might better be regarded as laminal denti-alveolars rather than pure dentals. Similarly, in these languages in which there is a contrasting coronal articulation, it is always apical with a smaller contact area. It is sometimes in the region in front of the center of the alveolar ridge, making it what we have defined as an alveolar articulation, but it may be on the center of the alveolar ridge, making it what we have called post-alveolar.

Some Dravidian languages have a three way contrast between places involving the tongue tip or blade, distinguishing dental, alveolar and what for the time being we will label retroflex stops. Toda examples are given in table 2.4. We investigated the articulatory characteristics of the Toda stops using palato-graphic analysis techniques which are fully described elsewhere (Ladefoged, in press). The basic procedure was to paint the tip, blade and front of the tongue with a mixture of edible oil and finely powdered charcoal. The speaker then said the word to be investigated, which was always carefully chosen so that it had only one coronal consonant. The pronunciation was recorded using a video camera, which was also used to photograph a mirror placed in the mouth so as to show the area of the upper part of the vocal tract that had been contacted. The procedure was then reversed, painting the upper part of the

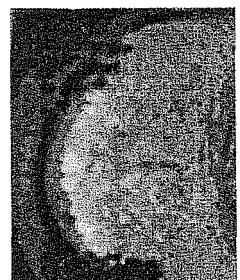
(a)  
dental  
t



(b)  
alveolar  
t



(c)  
retroflex  
t



tongue contacts. These stops were always made with the tip of the tongue contacting the middle of the alveolar ridge, making them clearly apical alveolars. The retroflex stops, exemplified in the lower pair of photographs, show very little contact on the tip of the tongue, as, instead of the tip itself, it was the underside of the tip that was involved, making these sounds sub-apical. The contact was between the curled back tip of the tongue and the roof of the mouth well behind the alveolar ridge, in the region of the hard palate. We will compare this retroflex articulation with others that have been labeled retroflex in a later section.

In general, if a language has only a dental or an alveolar stop, then that stop will be laminal if it is dental and apical if it is alveolar. But generalizations such as these should be treated with reserve. Most textbooks describe French t, d, n, l as laminal dental and English t, d, n, l as apical alveolar. But Dart (1991) has shown that 20-30% of her sample of 20 speakers of French used alveolar gestures for some of these sounds (the percentage differing for different members of the set), and similar percentages of Californian English speakers used dental articulations.

There are comparatively few languages in which a dental stop is required to be apical. This is, however, the case in Temne, a West Atlantic language spoken in Sierra Leone, which breaks the generalization that languages that contrast dental and alveolar stops have laminal dentals and apical alveolars. In Temne the stop made on the teeth is articulated with the tip of the tongue, and the one made on the alveolar ridge, which is slightly affricated, involves the blade of the tongue.

Similarly there are not many clear cases in which a laminal articulation is required for alveolar gestures for stops or nasals; but, from the x-ray tracings in Stojkov (1942, 1961), it seems as if the major part of the difference between plain t, d, n and what are traditionally called palatalized t, d, n in Bulgarian is that the former are produced with an apical alveolar gesture, and the latter with a laminal alveolar gesture, i.e. as t, d, n. As Scatton (1984: 60) remarks "the extent to which the mid-body of the tongue is raised is not very much greater than that of their non-palatalized counterparts." The difference be-