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## 2 The production of speech sounds

### 2.1 Articulators above the larynx

All the sounds we make when we speak are the result of muscles contracting. The muscles in the chest that we use for breathing produce the flow of air that is needed for almost all speech sounds; muscles in the **larynx** produce many different modifications in the flow of air from the chest to the mouth. After passing through the larynx, the air goes through what we call the **vocal tract**, which ends at the mouth and nostrils; we call the part comprising the mouth the **oral cavity** and the part that leads to the nostrils the **nasal cavity**. Here the air from the lungs escapes into the atmosphere. We have a large and complex set of muscles that can produce changes in the shape of the vocal tract, and in order to learn how the sounds of speech are produced it is necessary to become familiar with the different parts of the vocal tract. These different parts are called **articulators**, and the study of them is called **articulatory phonetics**.

Fig. 1 is a diagram that is used frequently in the study of phonetics. It represents the human head, seen from the side, displayed as though it had been cut in half. You will need to look at it carefully as the articulators are described, and you will find it useful to have a mirror and a good light placed so that you can look at the inside of your mouth.

- i) The **pharynx** is a tube which begins just above the larynx. It is about 7 cm long in women and about 8 cm in men, and at its top end it is divided into two, one

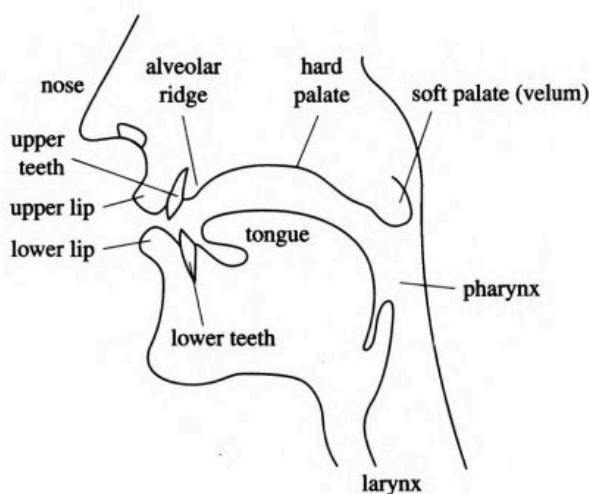


Fig. 1 The articulators

part being the back of the oral cavity and the other being the beginning of the way through the nasal cavity. If you look in your mirror with your mouth open, you can see the back of the pharynx.

- ii) The **soft palate** or **velum** is seen in the diagram in a position that allows air to pass through the nose and through the mouth. Yours is probably in that position now, but often in speech it is raised so that air cannot escape through the nose. The other important thing about the soft palate is that it is one of the articulators that can be touched by the tongue. When we make the sounds k, g the tongue is in contact with the lower side of the soft palate, and we call these **velar** consonants.
- iii) The **hard palate** is often called the “roof of the mouth”. You can feel its smooth curved surface with your tongue. A consonant made with the tongue close to the hard palate is called **palatal**. The sound j in ‘yes’ is palatal.
- iv) The **alveolar ridge** is between the top front teeth and the hard palate. You can feel its shape with your tongue. Its surface is really much rougher than it feels, and is covered with little ridges. You can only see these if you have a mirror small enough to go inside your mouth, such as those used by dentists. Sounds made with the tongue touching here (such as t, d, n) are called **alveolar**.
- v) The **tongue** is a very important articulator and it can be moved into many different places and different shapes. It is usual to divide the tongue into different parts, though there are no clear dividing lines within its structure. Fig. 2 shows the tongue on a larger scale with these parts shown: **tip**, **blade**, **front**, **back** and **root**. (This use of the word “front” often seems rather strange at first.)
- vi) The **teeth** (upper and lower) are usually shown in diagrams like Fig. 1 only at the front of the mouth, immediately behind the lips. This is for the sake of a simple diagram, and you should remember that most speakers have teeth to the sides of their mouths, back almost to the soft palate. The tongue is in contact with the upper side teeth for most speech sounds. Sounds made with the tongue touching the front teeth, such as English  $\theta$ ,  $\delta$ , are called **dental**.

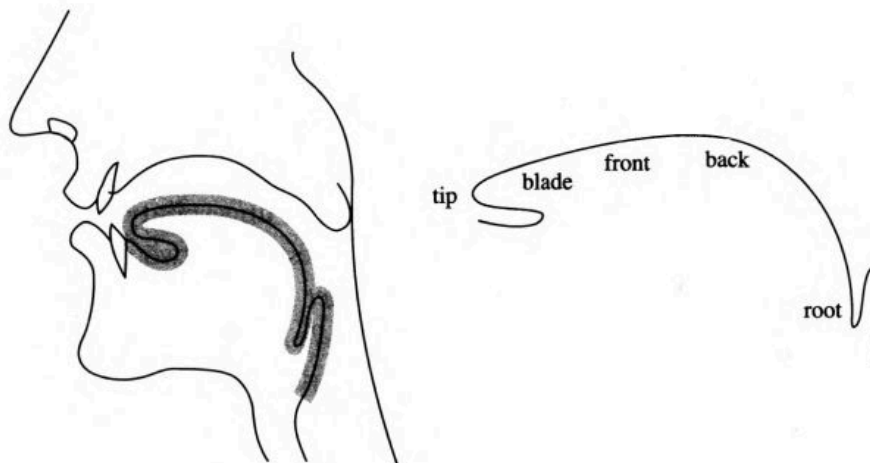


Fig. 2 Subdivisions of the tongue

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- vii) The **lips** are important in speech. They can be pressed together (when we produce the sounds p, b), brought into contact with the teeth (as in f, v), or rounded to produce the lip-shape for vowels like u:. Sounds in which the lips are in contact with each other are called **bilabial**, while those with lip-to-teeth contact are called **labiodental**.

The seven articulators described above are the main ones used in speech, but there are a few other things to remember. Firstly, the larynx (which will be studied in Chapter 4) could also be described as an articulator – a very complex and independent one. Secondly, the **jaws** are sometimes called articulators; certainly we move the lower jaw a lot in speaking. But the jaws are not articulators in the same way as the others, because they cannot themselves make contact with other articulators. Finally, although there is practically nothing active that we can do with the **nose** and the nasal cavity when speaking, they are a very important part of our equipment for making sounds (which is sometimes called our **vocal apparatus**), particularly nasal consonants such as m, n. Again, we cannot really describe the nose and the nasal cavity as articulators in the same sense as (i) to (vii) above.

## 2.2 Vowel and consonant

The words **vowel** and **consonant** are very familiar ones, but when we study the sounds of speech scientifically we find that it is not easy to define exactly what they mean. The most common view is that vowels are sounds in which there is no obstruction to the flow of air as it passes from the larynx to the lips. A doctor who wants to look at the back of a patient's mouth often asks them to say "ah"; making this vowel sound is the best way of presenting an unobstructed view. But if we make a sound like s, d it can be clearly felt that we are making it difficult or impossible for the air to pass through the mouth. Most people would have no doubt that sounds like s, d should be called consonants. However, there are many cases where the decision is not so easy to make. One problem is that some English sounds that we think of as consonants, such as the sounds at the beginning of the words 'hay' and 'way', do not really obstruct the flow of air more than some vowels do. Another problem is that different languages have different ways of dividing their sounds into vowels and consonants; for example, the usual sound produced at the beginning of the word 'red' is felt to be a consonant by most English speakers, but in some other languages (e.g. Mandarin Chinese) the same sound is treated as one of the vowels.

If we say that the difference between vowels and consonants is a difference in the way that they are produced, there will inevitably be some cases of uncertainty or disagreement; this is a problem that cannot be avoided. It is possible to establish two distinct groups of sounds (vowels and consonants) in another way. Consider English words beginning with the sound h; what sounds can come next after this h? We find that most of the sounds we normally think of as vowels can follow (e.g. e in the word 'hen'), but practically none of the sounds we class as consonants, with the possible exception of j in a word such as 'huge' hju:dʒ. Now think of English words beginning with the two sounds bɪ; we find many cases where a consonant can follow (e.g. d in the word 'bid', or l in the word 'bill'),

but practically no cases where a vowel may follow. What we are doing here is looking at the different contexts and positions in which particular sounds can occur; this is the study of the **distribution** of the sounds, and is of great importance in phonology. Study of the sounds found at the beginning and end of English words has shown that two groups of sounds with quite different patterns of distribution can be identified, and these two groups are those of vowel and consonant. If we look at the vowel–consonant distinction in this way, we must say that the most important difference between vowel and consonant is not the way that they are made, but their different distributions. It is important to remember that the distribution of vowels and consonants is different for each language.

We begin the study of English sounds in this course by looking at vowels, and it is necessary to say something about vowels in general before turning to the vowels of English. We need to know in what ways vowels differ from each other. The first matter to consider is the shape and position of the tongue. It is usual to simplify the very complex possibilities by describing just two things: firstly, the vertical distance between the upper surface of the tongue and the palate and, secondly, the part of the tongue, between front and back, which is raised highest. Let us look at some examples:

- i) Make a vowel like the *i:* in the English word ‘see’ and look in a mirror; if you tilt your head back slightly you will be able to see that the tongue is held up close to the roof of the mouth. Now make an *æ* vowel (as in the word ‘cat’) and notice how the distance between the surface of the tongue and the roof of the mouth is now much greater. The difference between *i:* and *æ* is a difference of tongue height, and we would describe *i:* as a relatively **close** vowel and *æ* as a relatively **open** vowel. Tongue height can be changed by moving the tongue up or down, or moving the lower jaw up or down. Usually we use some combination of the two sorts of movement, but when drawing side-of-the-head diagrams such as Fig. 1 and Fig. 2 it is usually found simpler to illustrate tongue shapes for vowels as if tongue height were altered by tongue movement alone, without any accompanying jaw movement. So we would illustrate the tongue height difference between *i:* and *æ* as in Fig. 3.

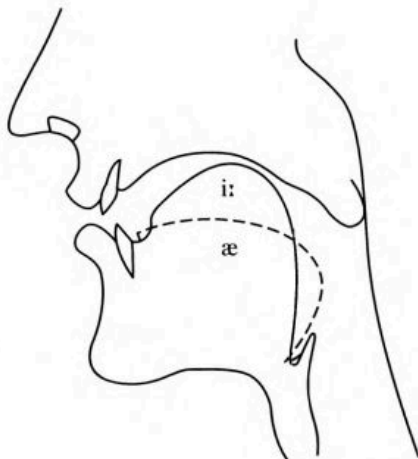


Fig. 3 Tongue positions for *i:* and *æ*

- ii) In making the two vowels described above, it is the front part of the tongue that is raised. We could therefore describe *i:* and *æ* as comparatively **front** vowels. By changing the shape of the tongue we can produce vowels in which a different part of the tongue is the highest point. A vowel in which the back of the tongue is the highest point is called a **back** vowel. If you make the vowel in the word 'calm', which we write phonetically as *ɑ:*, you can see that the back of the tongue is raised. Compare this with *æ* in front of a mirror; *æ* is a front vowel and *ɑ:* is a back vowel. The vowel in 'too' (*u:*) is also a comparatively back vowel, but compared with *ɑ:* it is close.

So now we have seen how four vowels differ from each other; we can show this in a simple diagram.

	Front	Back
Close	<i>i:</i>	<i>u:</i>
Open	<i>æ</i>	<i>ɑ:</i>

However, this diagram is rather inaccurate. Phoneticians need a very accurate way of classifying vowels, and have developed a set of vowels which are arranged in a close–open, front–back diagram similar to the one above but which are not the vowels of any particular language. These **cardinal vowels** are a standard reference system, and people being trained in phonetics at an advanced level have to learn to make them accurately and recognise them correctly. If you learn the cardinal vowels, you are not learning to make English sounds, but you are learning about the range of vowels that the human vocal apparatus can make, and also learning a useful way of describing, classifying and comparing vowels. They are recorded on Track 12 of CD 2.

It has become traditional to locate cardinal vowels on a four-sided figure (a quadrilateral of the shape seen in Fig. 4 – the design used here is the one recommended by the **International Phonetic Association**). The exact shape is not really important – a square would do quite well – but we will use the traditional shape. The vowels in Fig. 4 are the so-called **primary** cardinal vowels; these are the vowels that are most familiar to the speakers of most European languages, and there are other cardinal vowels (**secondary** cardinal vowels) that sound less familiar. In this course cardinal vowels are printed within square brackets [ ] to distinguish them clearly from English vowel sounds.

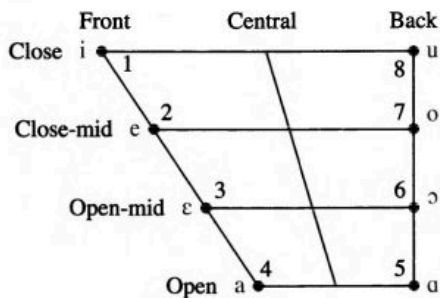


Fig. 4 Primary cardinal vowels



Cardinal vowel no. 1 has the symbol [i], and is defined as the vowel which is as close and as front as it is possible to make a vowel without obstructing the flow of air enough to produce friction noise; friction noise is the hissing sound that one hears in consonants like s or f. Cardinal vowel no. 5 has the symbol [ɑ] and is defined as the most open and back vowel that it is possible to make. Cardinal vowel no. 8 [u] is fully close and back and no. 4 [a] is fully open and front. After establishing these extreme points, it is possible to put in intermediate points (vowels no. 2, 3, 6 and 7). Many students when they hear these vowels find that they sound strange and exaggerated; you must remember that they are *extremes* of vowel quality. It is useful to think of the cardinal vowel framework like a map of an area or country that you are interested in. If the map is to be useful to you it must cover all the area; but if it covers the whole area of interest it must inevitably go a little way beyond that and include some places that you might never want to go to.

When you are familiar with these extreme vowels, you have (as mentioned above) learned a way of describing, classifying and comparing vowels. For example, we can say that the English vowel æ (the vowel in 'cat') is not as open as cardinal vowel no. 4 [a]. We have now looked at how we can classify vowels according to their tongue height and their frontness or backness. There is another important variable of vowel quality, and that is lip-position. Although the lips can have many different shapes and positions, we will at this stage consider only three possibilities. These are:

- i) **Rounded**, where the corners of the lips are brought towards each other and the lips pushed forwards. This is most clearly seen in cardinal vowel no. 8 [u].
- ii) **Spread**, with the corners of the lips moved away from each other, as for a smile. This is most clearly seen in cardinal vowel no. 1 [i].
- iii) **Neutral**, where the lips are not noticeably rounded or spread. The noise most English people make when they are hesitating (written 'er') has neutral lip position.

Now, using the principles that have just been explained, we will examine some of the English vowels.

### 2.3 English short vowels

⌚ AU2 (CD 1), Exs 1–5

English has a large number of vowel sounds; the first ones to be examined are short vowels. The symbols for these short vowels are: i, e, æ, ʌ, ɒ, ʊ. Short vowels are only *relatively* short; as we shall see later, vowels can have quite different lengths in different contexts.

Each vowel is described in relation to the cardinal vowels.

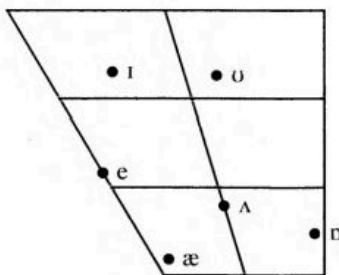


Fig. 5 English short vowels

- i (example words: 'bit', 'pin', 'fish') The diagram shows that, though this vowel is in the close front area, compared with cardinal vowel no. 1 [i] it is more open, and nearer in to the centre. The lips are slightly spread.
- e (example words: 'bet', 'men', 'yes') This is a front vowel between cardinal vowel no. 2 [e] and no. 3 [ɛ]. The lips are slightly spread.
- æ (example words: 'bat', 'man', 'gas') This vowel is front, but not quite as open as cardinal vowel no. 4 [a]. The lips are slightly spread.
- ʌ (example words: 'cut', 'come', 'rush') This is a central vowel, and the diagram shows that it is more open than the open-mid tongue height. The lip position is neutral.
- ɒ (example words: 'pot', 'gone', 'cross') This vowel is not quite fully back, and between open-mid and open in tongue height. The lips are slightly rounded.
- ʊ (example words: 'put', 'pull', 'push') The nearest cardinal vowel is no. 8 [u], but it can be seen that ʊ is more open and nearer to central. The lips are rounded.

There is one other short vowel, for which the symbol is ə. This central vowel – which is called **schwa** – is a very familiar sound in English; it is heard in the first syllable of the words 'about', 'oppose', 'perhaps', for example. Since it is different from the other vowels in several important ways, we will study it separately in Chapter 9.

### Notes on problems and further reading

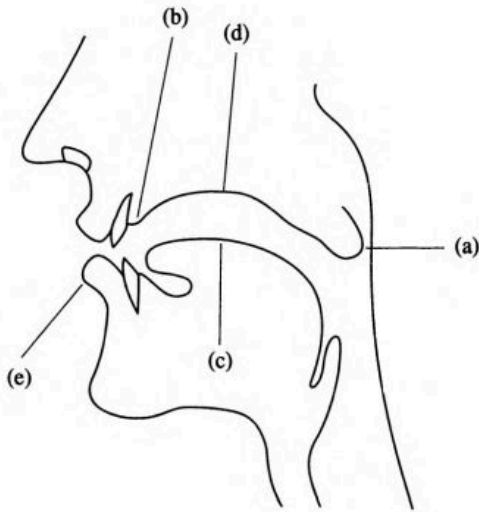
One of the most difficult aspects of phonetics at this stage is the large number of technical terms that have to be learned. Every phonetics textbook gives a description of the articulators. Useful introductions are Ladefoged (2006: Chapter 1), Ashby (2005), and Ashby and Maidment (2005: Chapter 3).

An important discussion of the vowel–consonant distinction is by Pike (1943: 66–79). He suggested that since the two approaches to the distinction produce such different results we should use new terms: sounds which do not obstruct the airflow (traditionally called “vowels”) should be called **vocoids**, and sounds which *do* obstruct the airflow (traditionally called “consonants”) should be called **contoids**. This leaves the terms “vowel” and “consonant” for use in labelling phonological elements according to their distribution and their role in syllable structure; see Section 5.8 of Laver (1994). While vowels are usually vocoids and consonants are usually contoids, this is not always the case; for example, j in 'yet' and w in 'wet' are (phonetically) vocoids but function (phonologically) as consonants. A study of the distributional differences between vowels and consonants in English is described in O'Connor and Trim (1953); a briefer treatment is in Cruttenden (2008: Sections 4.2 and 5.6). The classification of vowels has a large literature: I would recommend Jones (1975: Chapter 8); Ladefoged (2006) gives a brief introduction in Chapter 1, and much more detail in Chapter 9; see also Abercrombie (1967: 55–60 and Chapter 10). The *Handbook of the International Phonetic Association* (1999: Section 2.6) explains the IPA's principles of vowel classification. The distinction

between primary and secondary cardinal vowels is a rather dubious one which appears to be based to some extent on a division between those vowels which are familiar and those which are unfamiliar to speakers of most European languages. It is possible to classify vowels quite unambiguously without resorting to this notion by specifying their front/back, close/open and lip positions.

### Written exercises

- 1 On the diagram provided, various articulators are indicated by labelled arrows (a–e). Give the names for the articulators.



- 2 Using the descriptive labels introduced for vowel classification, say what the following cardinal vowels are:
- a) [u]            b) [e]            c) [a]            d) [i]            e) [o]
- 3 Draw a vowel quadrilateral and indicate on it the correct places for the following English vowels:
- a) æ            b) ʌ            c) ɪ            d) e
- 4 Write the symbols for the vowels in the following words:
- a) bread            b) rough            c) foot            d) hymn  
e) pull            f) cough            g) mat            h) friend