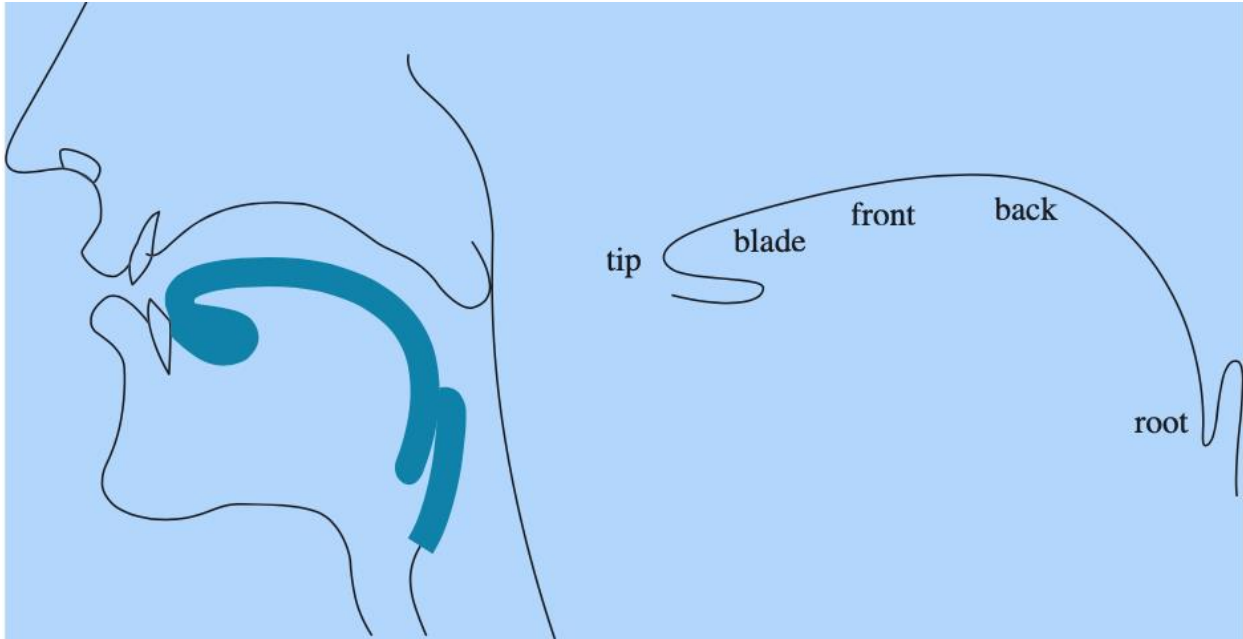


Tongue Shapes

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:



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.

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.

	Front	Back
Close	i:	u:
Open	æ	ɑ:

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 recognize them correctly.

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.

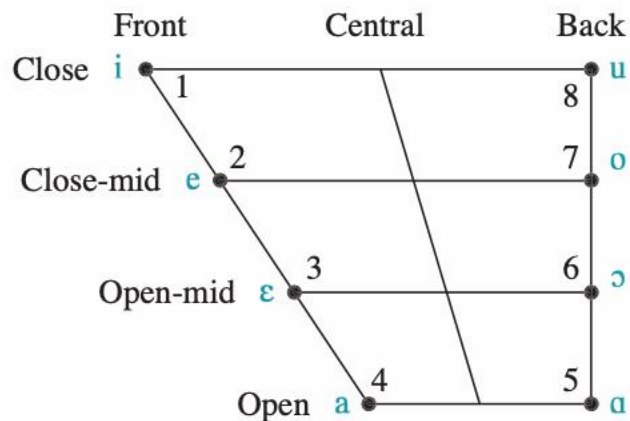


Fig. 4 Primary cardinal vowels

Tongue & Formants

Height:

Theoretically, vowel height refers to the vertical position of either the tongue or the jaw (depending on the model) relative to either the roof of the mouth or the aperture of the [jaw](#). In practice, however, it refers to the first [formant](#) (lowest resonance of the voice), abbreviated F1, which is associated with the height of the tongue. In close vowels, also known as high vowels, such as [i] and [u], the first formant is consistent with the tongue being positioned close to the palate, high in the mouth, whereas in open vowels, also known as low vowels, such as [a], F1 is consistent with the jaw being open and the tongue being positioned low in the mouth. Height is defined by the inverse of the F1 value: The higher the frequency of the first formant, the lower (more open) the vowel.

Backness:

Vowel backness is named for the position of the tongue during the articulation of a vowel relative to the back of the mouth. As with vowel height, however, it is *defined* by a formant of the voice, in this case the second, F2, not by the position of the tongue. In front vowels, such as [i], the frequency of F2 is relatively high, which generally corresponds to a position of the tongue forward in the mouth, whereas in back vowels, such as [u], F2 is low, consistent with the tongue being positioned towards the back of the mouth.

Cardinal System

Vowels are produced in a relatively small area of the mouth - earlier writers talked of palatal vowels (the frontmost ones) and velar vowels (the furthest back). The tongue may be further to the front or to the back and higher or lower in the mouth (as shown in [this video clip](#) or [this video](#) of "peat, pit, pet, pat, putt ...") and the lips may be more or less rounded.

The tongue arching model. Vowels can be classified according to (and so points on the quadrilateral represent) the position of the highest point of the tongue in forming the vowel. The first things one needs to know, therefore, when categorizing vowels are:

(i) How high is the highest point of the tongue? (the **height** of the vowel.) Is it **close** to the roof of the mouth, as for [i], i.e. with the tongue as near the roof of the mouth as it can get without causing friction - or **open** as for [ɑ], with the tongue as low in the mouth and the jaws as wide open as possible; or is it intermediate between these two - either **close-mid**, like [e] as in French "donner"; or **open-mid** like [ɛ] as in French "père"? Of course, the majority of sounds do not correspond exactly to any of these, but using these categories allows us to describe them accurately.

(ii) How far forward or back is the highest point of the tongue? Is it **front** - corresponding to a palatal consonant - such as [i], [e], [ɛ] and [a], or **back** - corresponding to a velar consonant - such as [u], [o], [ɔ] and [ɑ]; or **central**, like the [ə:] sound in English "bird" or "hurt".

These eight cardinal vowels are numbered as follows: 1 [i], 2 [e], 3 [ɛ], 4 [a], 5 [ɑ], 6 [ɔ], 7 [o], and 8 [u].

Primary Cardinal Vowels

	<i>Front</i>	<i>Back</i>
<i>Close</i>	i	u
<i>Close-mid</i>	e	o
<i>Open-mid</i>	ɛ	ɔ
<i>Open</i>	a	ɑ

Secondary Cardinal Vowels

<i>Front</i>	<i>Back</i>
y	ɯ
ø	ɤ
œ	ʌ
ɶ	ɒ