8. Vowels & vocoids

Luciano Canepari's 2013 updating of *canIPA* vocoids in *Natural Phonetics & Tonetics*

8.1. In this chapter, we will explain –in depth– the articulations of vowels. We refer to vowels as VOCOIDS, or *vowel phones*, when looking at them from an exclusively phonetic point of view. Instead, when we speak of their distinctive role in a particular language, we will call them VOWELS, or *vowel phonemes*. In the case of graphic symbols, we will again speak of VOWELS, or of *vowel graphemes*. It should be clear, in the first place, that the *matter* (*ie* SOUNDS) and *substance* (*ie* PHONES) must be fully grasped, given that these elements constitute the essence of vowel articulations. Everything else is necessarily secondary, including the *form* (*ie* the phonemes of a given language).

The characteristic quality of vocoids depends on the shape assumed by the ARTICULATORY CHANNEL while they are being formed. Specifically, we mean their *position*, determined by the raising and forward–backward movement of the back of the tongue, as well as by the shape imparted to the *lips*. Acoustic and radiographic phoneticians give too much importance to the inevitable and objective fact that the pharyngeal cavity is wider with front vocoids, since the tongue mass has been moved forwards. As vocoids move farther and farther back, the dimensions of the pharyngeal cavity automatically become smaller, all the way to the point of true back vocoids.

It is true that this change implies a difference in the shape of the 'articulatory channel', and that this difference, in turn, produces alterations in the physical (but not physiological) processes which affect the sound wave. The result is a change in the acoustic measurements; but all this has little relevance to the actual articulatory intentions, as should be quite clear.

Thus the production of vocoids has three fundamental components, not counting the expiratory air which makes them possible and gives them VOICING, by vibrating the vocal folds (at least in the case of the more common vocoids). As a matter of fact, it will be seen later that further modifications of vocoids are possible, potentially regarding articulation &/or phonation, particularly in certain specific languages.

For now, however, we will discuss the *three* fundamental components of vocoids (naturally returning to other topics which have already been mentioned): *vertical* RAISING of the back of the tongue (in cooperation with movement of the jaw), in the direction HIGH–LOW; *horizontal* FORWARDS–BACKWARDS MOVEMENT along the FRONT–BACK direction: and finally, *lip* ROUNDING, according to the alternation ROUND–SPREAD. Therefore, the components can be summarized in TONGUE POSITION (both vertical and horizontal, of the back of the tongue), and LIP SHAPE.

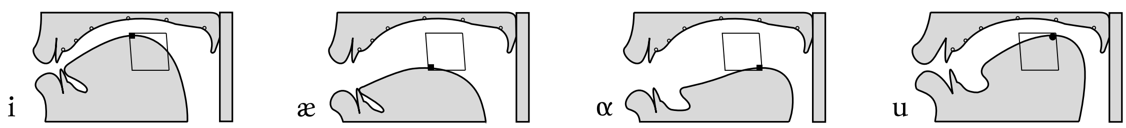
8.2. The older, prescientific method of describing the 'vowels' of a foreign language typically involved making vague references to the sounds 'hypothesized' for one's own language, together with occasional comparisons with some other 'better-known' widely-spoken European languages, for significantly different sounds. It was not realized that the vocoid systems of two languages never correspond satisfactorily. Also neglected was another point which is clear to us today: that no two people speak the same language in exactly the same way, since there are individual, regional, and sociocultural differences of pronunciation which are often quite notable.

It is therefore necessary to analyze the vocoids of a language by following a scientific approach, working independently of any particular language while nonetheless making solid connections to the precise inventories of a great number of natural languages. This approach is called the phonetic method. The first step in the method involves understanding the vocoids of one's mother tongue (which does not necessarily coincide with the national or official language). With this beginning, it is then possible to move on to pronouncing any vocoid in any language.

8.3. vocoids are by nature in opposition to the other category of segmental sounds, the *contoids*. In fact, vocoids are distinguished particularly by being (relatively) static, by a fair amount of distance between the articulators, and also by having their articulation restricted to a limited physical area within the oral space (constituted effectively by the area ranging from the zone of the prevelum to the boundaries of the palate and the velum, as can be seen in fig 5.1 and fig 8.1). Their static nature, articulatory distance, and limited range, are in contrast to the *movement,* articulatory *proximity*, and *extended* range of articulations characteristic of the contoids. In fact, these last can be produced in every possible articulatory zone, including very peripherical ones, such as the lips, the teeth, the pharynx, the larynx, &c.

For vocoids, the *position* (or *shape*) imparted to the lips is also essential (as already stated above). This component of the articulation is independent and non-contiguous with respect to that of the back of the tongue. Moreover, the involvement of the glottis is usually assumed to be part of the articulation, and the result is voicing. Voicing gives greater substance and resonance to vocoids, thereby making them easier to distinguish and recognize in their particular timbres, 52 in all, together with further nuances which are equally perceptible and recognizable, and reproducible as well. On the other hand, voiceless vocoids are also possible, even though here the individuality of the particular timbres is naturally diminished. Voiceless vocoids can even be used distinctively as phonemes in certain languages, opposing the more 'normal' voiced phonemes (*cf* § 11.18).

fig 8.1. Articulatory space for vocoids.



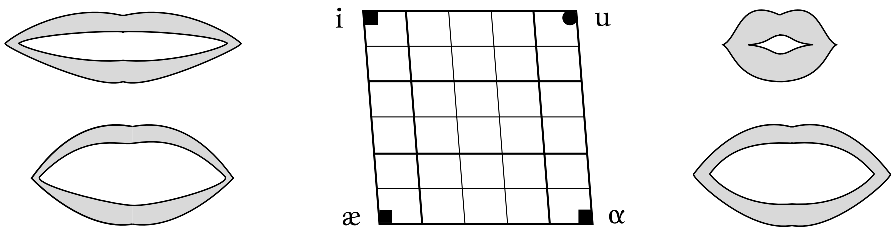
8.4. Therefore, vocoids are phones in which the expiratory air passes freely out of the mouth, moving along the middle part of the back of the tongue. The tongue position is (relatively) rather stable throughout the duration of the phone. Moreover, the opening of the jaw (and naturally, also the space between the back of the tongue and the palate) is never less than that found in dorsal approximants, such as [j, ɥ; ɰ, w]. As was seen in § 5.5-6, this last group is characterized by a less stable and quicker articulation than the corresponding vocoids, [i, y; ɯ, u]. For the various positions of the back of the tongue and of the lips, in the course of vocoid articulations, *cf fig* 8.6-9.

There exist vocoids with greater jaw opening as well, passing through intermediate stages until reaching the level of true open vocoids. It will be immediately seen that it is helpful to classify the different vocoids in six degrees of jaw opening, organized into three groups. We see now –once again– that vocoids have a limited zone of production, in terms of the height of the tongue and the jaw. The mouth must be appropriately open, but not too much, so that a natural articulation which combines fluidly vocoids and contoids is possible. The opening should not be overly narrow either, since otherwise unhelpful friction and noises would be produced (which would also be annoying while communicating with others).

Moreover, there needs to be enough space between the open and close degrees to make it possible to distinguish cleanly the intermediate levels, which are variously used by the different languages. Therefore, for purposes of classification, this space is subdivided into three horizontal zones: close, mid, and open. Each one of these is in turn subdivided into an upper or lower part, thereby allowong further internal distinctions.

In this manner, one obtains the following six –successively greater– degrees of tongue/jaw opening for vocoids: high, lower-high; higher-mid, lower-mid; higher-low, low; whose existence can also be demonstrated experimentally with, for example, *x*-ray photographs or films.

fig 8.2. Vocograms and labiograms of vocoids in the extreme positions.



8.5. In order to investigate the natural limits of the area of vocoid articulations, the author used *x*-rays and a small metal chain, with a coated lead ball in the center. The chain was then extended along the longitudinal groove of the tongue so that the lead ball would coincide in position with the center of the back of the tongue (the position of the lead ball is shown in *fig* 8.1, where it is magnified so as to be more evident, and it is furthermore represented with a square marker, except in the case of [u]). In this way, it is possible to detect the horizontal and vertical movement of the tongue, together with its shape with respect to various fixed points on the palatal vault, while various vocoids are being articulated. In order to ensure that the articulations were natural, photographs of speech made with and without the chain were compared (as well as the corresponding magnetic or electronic recordings).

The essential point, therefore, is to succeed in identifying accurately the full range of (horizontal and vertical) movement of the lead ball, during the articulation of the most extreme possible vocoids, uttered in a natural way. One such result is that the highest and frontest possible vocoid is [i] (*fig* 8.1, where we give precisely those points on the vocogram which are most extreme and peripheral). Raising the tongue further, we inevitably pass (through the palatal approximant [j], *fig* 5.1 & *fig* 10.6.1, towards the end of the first part of the figure) to a point where friction is produced, resulting thereby in the voiced palatal constrictive contoid, [j̡] (*fig* 10.5.1, at the beginning of the last but three row). Moving the tongue forward, as well, the quality of vocoids would be lost, resulting in a timbre more like that of a contoid.

[Especially non-phoneticians will frown on this (perfectly grammatical superlative) *the frontest*, preferring 'the most forward', or even 'the most front'. The same holds true of *the backest*, in comparison with 'the most retracted/back', and of the corresponding comparatives: *fronter*, *backer*.]

The highest and backest vocoid possible is [u] (*fig* 8.1). Raising the tongue further, the resulting phone passes through the velar rounded [w] (*fig* 5.1 & *fig* 10.6.1, at the beginning of the last but two row), before yielding the voiced velar (rounded) constrictive [ɣ̊] (*fig* 10.5.1, third orogram in the last but two row); while moving the tongue farther back, the result would be the uvular rounded constrictive, [ʁ̂] (*fig* 10.5.1, the first in the last but one row).

The lowest and backest vocoid possible is [ɑ] (*fig* 8.1). Moving the tongue farther back, the result would be the prepharyngeal approximant contoid, [ʕ] (*fig* 10.6.1, the first in the last row), and moving still farther, we encounter the prepharyngeal constrictive, [ɦ] (*fig* 10.5.1, the last one in the last row), where both of these are voiced.

Combining the level of jaw opening characteristic of [ɑ] and the forward position of the tongue found in [i], we come to the lowest and frontest possible vocoid, [æ] (*fig* 8.1), which constitutes the articulation most different from that of the contoids, with which it in fact has no natural connection or similarity (unlike in the other cases mentioned here). We (the author and many others) have already explained that [æ] is actually a *low* front vocoid (even though the *offIPA* continues to describe this vowel as higher than it actually is), as the acoustic analyses themselves clearly demonstrate.

8.6. Joining together these four points, in a schematic way in order to be more practical, and enlarging the figure, we arrive at the vocoidal quadrilateral, or VOCOGRAM (*fig* 8.2), into which all vocoid phones possible in any language can be placed. (Concerning possible modifications of these, *cf* § 11.17-19.)

The left side of the vocogram is thus the front limit of the articulatory area for vocoids, while the right side is the back limit. The space between these two limiting barriers can be usefully divided into five columns. On the ends, we have the FRONT and BACK vocoids; in the middle, there are the CENTRAL ones. Since it has been proved worthwhile to use specific markers also for phones in the areas comprised between these strips, the two other vocoid columns are referred to as FRONT-CENTRAL and BACK-CENTRAL respectively.

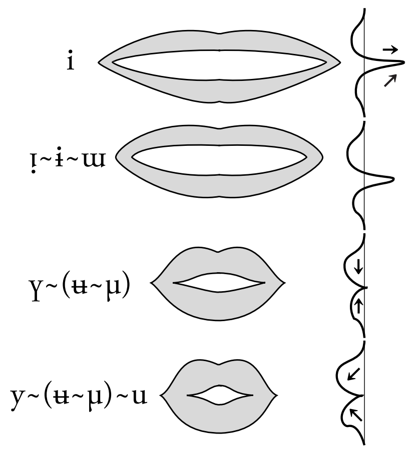
Observing the vocogram of the phones which are *unmarked* (in the sense of being unrounded – *fig* 8.3, first vocogram, columns 0-4), we see that in the back region, the four closed and mid boxes have their vocoid symbols placed in parentheses. This is due to the fact that when back unrounded vocoids are found in languages (mostly Eastern Asian ones), these vocoids, ([ɯ, ɰ, ɤ, ɤ̞]), are articulated farther forward than [u, ʊ, o, σ].

They are therefore more accurately defined as BACK-CENTRAL vocoids, rather than purely back ones. If, one day, a language should be found possessing vocoids in the area of these four boxes, an appropriate symbol can always be brought into use. These supplementary symbols, prepared according to the principles leading to the expansion of this present *handbook*, are, in fact: [ɯ, ɰ, x, x].

We move ahead, now, to the vocogram of the rounded phones, which are *marked* because of being produced with lip rounding (*fig* 8.3, second vocogram, columns 5-9). Here it can be seen that, corresponding inversely to what occurs with unrounded vocoids, the four mid and low front boxes have symbols placed in parentheses. In fact, the vocoids [y, ʏ; ø, ø̞; œ], occurring in languages such as French and German, are articulated farther back than [i, ɪ; e, ᴇ; ɛ], and are therefore defined more accurately to be FRONT-CENTRAL vocoids. If symbols for truly front rounded vocoids in these areas should become necessary, it could be possible to use [ø, ø̞, ɶ, ɶ].

fig 8.3. The 52 vocoids of *canIPA* (with the 8 'potential' ones) and labiograms for the high ones.

	front	front-central	central	back-central	back	front rounded	front-central round.	central rounded	back-central round.	back rounded		
	0	1	2	3	4	5	6	7	8	9		
	i	ị	ɨ	ɯ	(ɯ)	γ	y	ʉ	μ	u	high (A)	CLOSE
	ɪ	ɩ	ᵻ	ɰ	(ɰ)	ч	ʏ	ᵿ	ω	ʊ	lower-high (B)	
	e	ɘ	ə	ɤ	(x)	(ø)	ø	ɵ	ɷ	o	higher-mid (C)	MID
	ᴇ	ᴲ	ɜ	ɤ̞	(x)	(ø̞)	ø̞	ɞ	ᴏ	σ	lower-mid (D)	
	ɛ	ɑ	ɐ	ʌ	ʌ̄	(ɶ)	œ	ɞ	ɘ	ɔ	higher-low (E)	OPEN
	æ	ᴀ	a	ɑ	α	(ɶ)	ɶ	ʚ	ɷ	ɒ	low (F)	



Instead of looking at just the position of the lead ball for vocoids, we can also consider the entire surface of the tongue, with respect to the palatal vault. From this point of view, we see that the position is practically the same as that found in less tense realizations of [j, w] (*cf fig* 8.1). For this reason, it might seem more logical to define the two vocoids [i, u] as 'palatal' and 'velar rounded', respectively, like the corresponding contoids. This would have the advantage of maintaining a (useful) connection between vocoids and contoids. However, there are three canonical 'places of articulation' for contoids in this area: palatal, prevelar, and velar (together with rounded versions of each of these); while there are necessarily five corresponding areas for vocoids (to be objective). One approach might be to name five different places of articulation, which could therefore be: palatal, postpalatal, prevelar, provelar, and velar (as, in fact, will be done later, when we seek to indicate nuances and distinctions relating to medial approximants –articulated with the medium-dorsum of the tongue– and similar contoids articulated nearby, *cf* § 10.13 and *fig* 10.12, by comparing them to the space of vocoids).

But it seems preferable to follow the terminology proposed above: FRONT, FRONT-CENTRAL, CENTRAL, BACK-CENTRAL, and BACK, in addition to the correspondent ROUNDED forms. In fact, it is appropriate to treat vocoids by means of the vocogram, both for learning and for teaching purposes.

Also alpha(nu)meric indications, using the numbers 0-4 and 5-9 together with the six heights, denoted with A-F, can be a useful way to refer to particular vocoids. This is particularly the case while speaking on the telephone, or while writing e--mail messages (without having to use attachments, which require both people to have the same fonts or being able to write and read *pdf* files). For example, we can write [a] = 2F, [i] = 0A, [u] = 9A, [ø] = 6C and [ə] = 2C...

Looking carefully, it can be seen that there is a certain difference between the roman 'zero': 0, and the letter *o* written in small capitals: O. The letter has a somewhat greater height than the numeral, and a different thickness, more like that of the roman lower case: o, differently from the numerals (which have much more homogenous shapes, and, in the case of the more traditional roman form of *1*, namely 1, a more evident serif, with respect to *i* in small capitals: I).

These numerals –0 1 2 3 4 5 6 7 8 9– are referred to as *lower case*, or *high and low*, or *traditional*, or *refined*, or also *typographic characters*, and they are definitely more elegant than the *upper case*, or *high*, or *modern*, or *common*, or *school characters* – 0 1 2 3 4 5 6 7 8 9.

Other less useful classifications

8.7. However, if one wished to remain completely faithful to the indications of the *x*-ray photograms, the result would be a complementary and rather different classification of the vocoids. According to the point of greatest closure of the articulatory channel, the vocoids would be apportioned into at least six places of articulation, and ten would not be by any means impossible. These would or could be: 'palatal, (postpalatal,) prevelar, (provelar,) velar, (postvelar,) uvular, uvulopharyngeal, (prepharyngeal,) pharyngeal'! In order to express the degree of progressive opening, the diagram would resemble a wheel hub with spokes coming out of it, pivoting on the area of [ɘ].

The result would be that, for example, from [i] to [ɛ], vocoids would be considered 'palatal'; from [u] to [ə], 'velar'; and from [æ] to [ɑ], 'pharyngeal'! But, a classification of this sort has no practical advantage, even as regards the complex phenomena of assimilation and coarticulation.

Rather, the subject would become needlessly complicated. Furthermore, the same 'love of the truth', if applied rigidly, could induce one to think of [i] (and the full series, even including [ɯ]) as 'bidental' vocoids; and also [u] (and the full series, even including [ɣ]) as bilabials, since the narrowest point of passage for the air in the articulatory channel is actually between the teeth, or between the lips, respectively. At this point, one would encounter the fresh problem of trying to come up with new terms, in order to distinguish between the members of these new and 'alien' series! Therefore, we will not speak of this classification any more – yet certain people, working exclusively with machines, seemed to consider it a more scientific approach.

In the meantime, the full validity of the articulatory (and auditory) classification has been fully and convincingly demonstrated. In fact, neither the 'highest point' of the tongue, nor the point of 'narrowest passage' between the articulators are particularly important for practical purposes. *Acoustically*, the shape of the articulatory channel determines the GLOTTOMETRICAL instrumental measurements; however, these are more speculative than practical. Instead, the GLOTTOGRAPHICAL data furnished by NATURAL PHONETICS (that is *articulatory* and *auditory*, as well as *functional*) give precious and essential information and descriptions, which are absolutely indispensable in learning and teaching.

But the fact of considering the 'highest point' of the tongue in the *x*-ray prints as the truly fundamental aspect led to a series of problems. In fact, the undeniably brilliant idea of Daniel Jones (to which the experiments of previous phoneticians also contributed) became manifested in a sort of deformed trapezoid, with the upper part much longer than the lower part, and the back part less long than the front part. The reasons for these asymmetries lie in precise physical barriers: the tongue is in fact more mobile in the high-front area than in the low-back area. It would have been better to adopt a partially different criterion with respect to that useful for contoids, for which a global articulation is decidedly more important.

Considering, instead, a *constant point*, namely the CENTER OF THE MEDIUMDORSUM (*ie* the absolute center of the back of the tongue, where the lead ball on the chain was placed during our early experiments), the resulting figure is similar to a much more regular quadrilateral. With modern technology, it is no longer necessary to use the chain and lead ball – better and more 'natural' results can be obtained with a few simple considerations and certain particular substances.

Even though any diagram with sharp corners is rather unnatural, it is still helpful to make the figure as schematic and regular as possible. Although simplified in this way, the diagram retains all of its usefulness in practical contexts, as will be seen in applications to languages and dialects.

8.8. Another defect was the attempt to subdivide the internal spaces between the four 'cardinal' points in the quadrilateral by means of an 'auditory equidistance', instead of continuing with ARTICULATORY SUBDIVISIONS, naturally, aided by AUDITORY FEEDBACK. It is quite clear that something which is purely auditory cannot be faithfully transmitted without a direct contact with the source or producer of the sound. In this manner, even the learning and training of specialized phoneticians has suffered, and the results have inevitably included undesired and unappreciated discrepancies, with respect to the articulatory method assisted by auditory feedback.

Those who have not become blinded uncritically in the conviction that the lowest and frontest vowel is '[a]', but instead try to do (articulatory &/or acoustic) phonetics without preconceptions and irrational biases, and to see directly what is going on, will necessarily arrive at the conclusion that the lowest and frontest possible vowel is certainly [æ]. For the sake of precision, given the partial difference between the two approaches in question, we should mention that the 'cardinal' value of '[a]' corresponds, in practice, to our [ᴀ] ([[ᴀ˂]]), which, in any case, is different both from [æ] and from [a] (given that it is practically halfway between these two vocoids, according to our classification).

Of course, it is not our responsibility to convince everyone that this is true, given that it would be simple and sufficient for anyone (even minimally) competent in the subject to check the matter personally, once the idea has been explained clearly. Nonetheless, we cite here some sources, who –with different principles and methods– have come to the same logical (and objective) conclusions: Delattre *et al.* (1951), Hyman (1975), Chapman *et al.* (1988[3]), without mentioning various contributions of the present writer. All things considered, it has been known for a ('relatively' short) time that the Earth is *not* flat and that the sun does *not* revolve around it! Just a question of 'points of view'?

8.9. At any rate, as the tongue is moved so as to produce successively all of the most external vocoids (those which are most PERIPHERAL in the diagram), the resulting figure is somewhat circular, a sort of lopsided oval. This can be seen in *fig* 6.1, where we move gradually from the more realistic to the more schematic, due to the practical reasons mentioned above.

Afterwards, we will see the orograms of all of the vocoids, in their medial values. By 'medial values', we mean the central position in their box, within the vocogram. It is useful to work from these values as starting points, which can be considered BASIC, FUNDAMENTAL, or CANONICAL. The 'cardinal' values used by Jones were instead as peripheral as possible in the vowel trapezoid, and as far from one another as possible. The Jonesian cardinal vowels (recorded on discs, *cf* Jones 1956), in all, were only 18 in number. They were subdivided into 'primary' cardinal vowels and 'secondary' ones: 'primary' [i, e, ɛ, a, ɑ; ɔ, o, u], and 'secondary' [y, ø, œ, ɶ, ɒ; ʌ, ɤ, ɯ], together with [ɨ; ʉ]. Moreover, the vowels of Jones were organized by reference to their frequency in the different languages of the world, with particular emphasis on the European languages. For this reason, the rounded and the more 'normal' unrounded vowels are 'mixed' together, instead of being presented in two homogeneous series, as in our approach. In any case it is unquestionably true that the *primary vowels* are more widely used in the various languages of the world, and that the *secondary vowels* are only added afterwards in learning phonetics (even if there are certainly exceptions, unless all the differences are leveled away in the context of a very abstract form of phonology).

In any case, in common practice, 8 additional vowels were usually added to the 18 'cardinal' ones: [ɩ/ɪ, ʏ, ɷ/ʊ; ə, ɵ, ɜ; ɐ; æ] (in practice, there were two notational variants, shown here separated by slashes, while [ɶ] was omitted –until the reform of 1979– because of not being documented in the descriptions of real languages).

The trapezoid of the most recent reform (finished in 1996) adds [ɘ, ɵ] and makes [ɪ, ʊ] official, thereby rejecting [ɩ, ɷ]. However, the value of each symbols has been made (even more) vague, within a fairly theoretical and 'potential' trapezoid; this is particularly true in the case of [ə].

The official location of [a] still suffers from the original limited use of symbols, for phonemic purposes, when it was enough to be able to distinguish two kinds of *a*, in respect of only one graphemic symbol. Therefore, one of the two extremes was denoted 'normally', with [a], while for the other a graphical variant of this symbol was used, whether derived from cursive script (as in the case of *a* [ɑ]), or from Greek, or from horizontal or vertical reflections of roman letters in some other cases. In certain types of intraphonemic transcription used for English, [æ] /æ/ was symbolized by '/a/', while [ɑː] /ɑː/ was simplified into '/aː/', and likewise [ɩ, ɷ] /ɪ, ʊ/ became '/i, u/', in opposition to [ɪi, ʊu/ɥu] /ɪi, ʊu/ represented (still today! – as has already been mentioned) with '/iː, uː/', as if the difference was only one of length.

The real problem of the 18 'cardinal vowels' (unlike our various canonical *canIPA* vocoids) is highlighted by the fact that they are not easy to be adequately reproduced even for trained phoneticians (not to speak of makeshift phoneticians, perhaps on the Internet). In fact, the *CV* (as they currently are) are just the pursuit of (almost) *unnatural boundaries* (obtained mostly auditorily, sometimes even for the four initial *CV*!).

Instead, we have to find those *articulatory positions* which can be *easy* for everyone to produce through their own organs, with no stressful excess (which, of course, does not mean that people are allowed to freely use the vocoids of their own language!). In addition, even the internal subdivisions must *not* be an (auditory) *imitation* of an absolute model, to be just reproduced parrot-fashion. On the contrary, they have to correspond to precise *articulatory gradations*, which must be calibrated for the mouth of each person, without 'cheating' (perhaps even unintentionally) by introducing *paraphonic* characteristics (precisely as voice imitators do), and playing with secondary tones or using supplementary modifications of the pharyngeal and labial cavities (exceeding what is natural).

More about vocoids

8.10. We have instead 52 symbols (or 60, including the eight available for articulations which have not yet been found in the languages of the world), and we use a vocogram with more rigorous subdivisions and clearly demarcated areas, which makes precision *obligatory*. In fact, it is not enough (for us, at least) to dump symbols here and there all over the diagram. Proceeding in this way, there is a serious risk of ending up with the common problem (unfortunately, seen in a great number of books) of trapezoids of the same language (and the same accent), which seem to be referring to very different languages, instead of just one. This problem occurs in the case of trapezoids made by different authors, but it can also occur with those of a single author (sometimes even within a single book). One cause is, of course, the excessively indeterminate nature of the official diagram, in which there are practically no internal subdivisions.

To present our vocoids, we use two separate vocograms, depending upon whether the lips are rounded or not (*cf* *fig* 8.3, *fig* 8.8, & *fig* 8.9). Of course, this separation is only methodological. In fact, while describing languages, vocoids should be given together, regardless of the shape of the lips. The shape of the lips is not ignored, however (as often happens, even with the official trapezoid), but is instead clearly marked by the shape of the markers placed in the positions of the relevant phones. Thus ROUNDED VOCOIDS have a CIRCULAR MARKER, while UNROUNDED ONES have a SQUARE one. This convention can be seen in all our vocograms, and in those in Ch 16-23, but in particular in those in *HPr*.

When vocoids occur with the lips in a position halfway between the two of these, that is HALF-ROUNDED, they are indicated by markers in the form of lozenges, or equiangular rhombi (thus, a square, rotated by 45°, *ie* a sort of diamond shape).

Therefore, in theory, we could have 26 vocoids more, by counting the half--rounded ones (and potentially 30, with the extra 4 unrounded vocoids not yet found in languages, but see § 8.29-31, as well).

So far, the most common ones have been: [i̮, ɨ̮, ɯ̮; ɪ̮, ɩ̮, ɯ̮; ɘ̮, ə̮, ɤ̮; ɜ̮, ɤ̮; ɐ̮, ʌ̮; æ̮, ᴀ̮, ɑ̮]. Labiograms for half-rounded vowels are shown in the central column of *fig* 8.9. In the same figure, it is also possible to see the differences between the two main types of lip rounding: the types with and without some protrusion of the lips. In the case of high vowels, where the differences are more evident, we have: with protrusion, [y, u], while without protrusion, [ʏ], and with half-rounded lips, [i̮, ɨ̮, ɯ̮]. In the case of [ʉ, µ], we have more commonly the type of rounding without protrusion; but the type with protrusion is also possible. Occasionally, rounding without protrusion can occur even with [y, u], in particular languages.

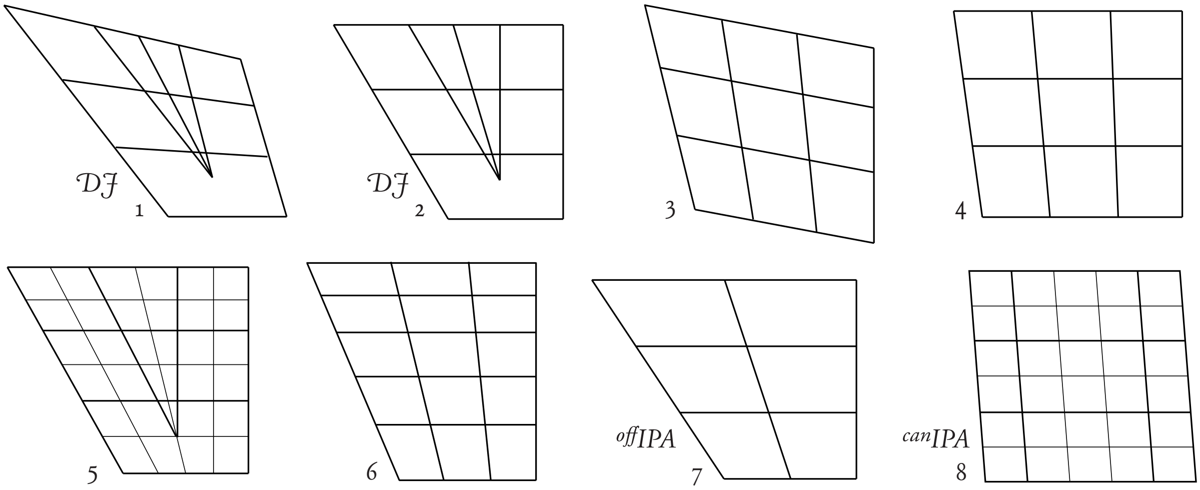
As has already been mentioned, the orograms (or sagittal cross-sections) also contain a sort of skeleton of the vocogram (the vowel quadrilateral). This 'skeleton' can then function as a reference for comparisons and contrasts, as well as for acquiring the vocoid in question. In the description of actual and particular languages, only the large vocogram need be used (and possibly multiple ones, if one alone is insufficient for the task of showing clearly all of the realizations possible).

In *fig* 8.4.1, we give a variety of vocoid diagrams (vocograms). The first two are those given by *Daniel Jones* (the first of these suffers, as can be seen by its shape, from the unfortunate fact of having considered as primary the 'highest point of the tongue', instead of a *fixed point*, *ie* the center of the mediumdorsum). The next four represent successive *developments* of these original diagrams. The seventh is the *official* diagram, given in the most recent reform (*offIPA*). The eighth is our own *quadrilateral* (*canIPA*), which is for us the VOCOGRAM *par excellence*, also seen, in a smaller size, in the orograms of *fig* 8.1, and, enlarged, in *fig* 8.2.

In order to make a useful comparison with the canonical *canIPA* vocoids (9 of which are different: 5 unrounded and 4 rounded), we have placed in *fig* 8.4.2(.1) the 18 official *cardinal vowels* of Daniel Jones. Here we list the latter in italics, to avoid any possible confusion: [*i, e, ɛ, a, ɑ, ɔ, o, u*], [*y, ø, œ, ɶ, ɒ, ʌ, ɤ, ɯ*], [*ɨ, ʉ*].

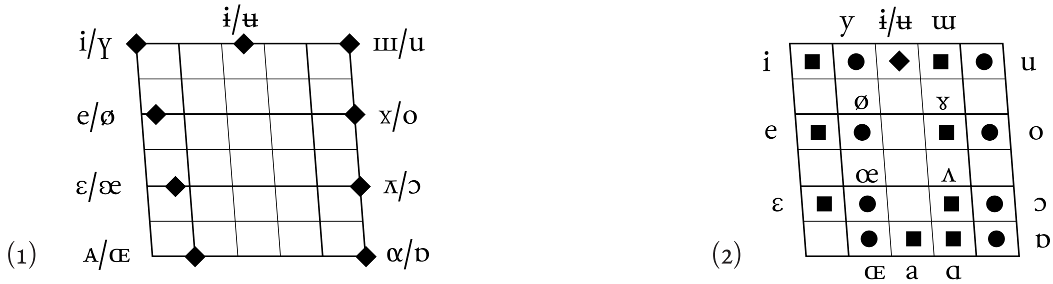
Were we to follow our own habitual ordering (which keeps the unrounded and rounded vocoids separate), we would have: [*i, e, ɛ, a, a, ʌ, ɤ, ɯ; ɨ*], [*y, ø, œ, ɶ, ɒ, ɔ, o, u; ʉ*], that is *canIPA*: [i, e, ɛ, ᴀ, α, ʌ, ɤ, ɯ; ɨ], [ʏ, ø, æ, ɶ, ɒ, ɔ, o, u; ʉ].

fig 8.4.1. Different types of diagrams for vocoids.



In *fig* 8.4.2(.2), again using *canIPA* symbols, we show the values most commonly attributed to these (official) symbols in phonetics treatises: [i, e, ɛ; ɨ, a; ɯ, ɤ, ʌ, ɑ], [y, ø, œ, ɶ; ʉ; u, o, ɔ, ɒ]; while the theoretical and peripheral values (which are found much more rarely, if at all) are better represented by other symbols (which, nevertheless, suggest their values): [ᴀ, α, ʌ, ɤ, ɯ], [ʏ, ø, æ], *fig* 8.4.2(.1).

fig 8.4.2. The *cardinal vowels* of Jones placed upon our vocogram using *canIPA* symbols (1) and *canIPA* values referring to 'cardinal' symbols (2).



The markers placed in *fig* 8.4.2(1) are those which, in our convention, are used for representing vocoids with 'intermediate' lip position, that is, half-rounded lips. The only purpose is to indicate simultaneously the two different articulations, rounded and unrounded, which were intentionally produced in the same points. The markers are located in the most extreme points, according to the criteria followed by Jones – in fact, their purpose was to bound the space of vocoids. In *fig* 8.4.2(2), instead, we have placed the appropriate markers in the centers of the relevant boxes, so that they will have our canonical values. In this way, the spirit of the two approaches to the vocoids of the world's languages can be better compared.

We have included *fig* 8.5 as well (for Spanish and for British English), in order to show two triangular vocoidal schemes which are decidedly not advisable, given that they do not respect the phonetic reality of the articulatory apparatus in various languages of the world. These are given in A.1-2, and despite their defects (the first is actually upside-down), they continue to be used. We have also provided the more common acoustic scheme (based on the first two formants, F1 and F2; note that 25 = 2500 Hz, 2 = 200 Hz) for Spanish (A.3, as in the stressed vowels of *uno, dos, tres, cuatro, cinco*) and for the 12 monophthongs of British English (B.1, as in: *city*, *to bring*, *to eat*, *book*, *beck*, *lack*, *luck*, *mark*, *mock*, *four*, *fur* [ˈsɪʈi, ʈhə-ˈbɻɪŋː, ʈhµˈɪiʈ, ˈbɷk, ˈbᴇk, ˈlæk, ˈlɐk, ˈmɑˑk, ˈmɒk, ˈfσː, ˈfɜː]. They are not derived from a triangle, but rather from a quadrilateral with the upper right corner part tilted to the right (although English /u/ is actually front-central). In this it differs from our quadrilateral, where that part tilts to the left (B.3), and from the current official compromise trapezoid (B.2), where that part is vertically straight. In this last case, it is easy to see the vagueness concerning subdivision, and the markers placed upon it which are always black and always round (regardless of lip position and stress). We have placed there the 12 vocoids (corresponding to 12 monophthongs) of neutral British English, which are then given again in our own faithful vocogram (B.3), together with all of its inherent advantages.

fig 8.5. Different ways of showing vocoids (5 Spanish and 12 British English monophthongs).

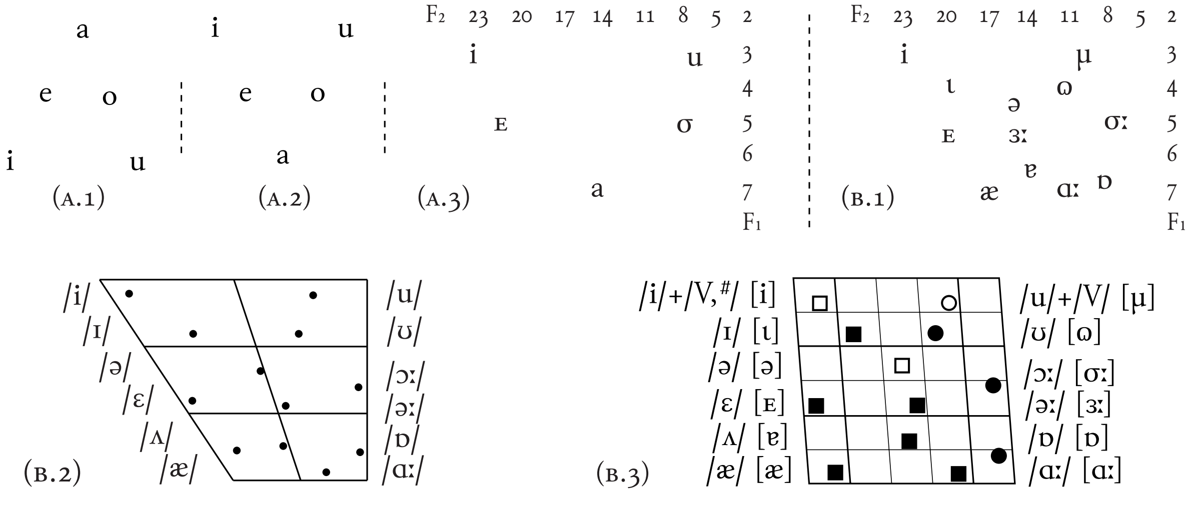


fig 8.6-7 show, respectively, the orograms and labiograms of the *12 vocoids* found in neutral British English, [i, ɩ, ᴇ, æ, ɐ, ɑː, ɒ, σː, ɷ, µ, ɜː, ə] (corresponding to the actual *monophthongs* of English, excluding thus cases such as *tea*, *two* /ˈtɪi, ˈtʊu/ [ˈʈhɪˑi, ˈʈhµˑu], which –clearly– are diphthongs, as we like to repeat).

8.11. With even a cursory examination of some of the vocograms in the phonosyntheses (and those for the 12 languages in *HPr*), it can be seen that a great level of precision is possible. Inside each box in the vocogram, the markers can be found located in a variety of different positions, even along the boundary lines at the border between two or more boxes. By simplifying somewhat, however, we can say that each vocoid has at least *nine* possible locations within a given box. Thus, besides a central [a] in its box, [a˔, a˃, a˧, a˅, a˕, a˂, a˫, a˂], as well. For instance, it is quite easy to hear different kinds of [a]-sounds in the first elements of the diphthongs /aɛ, aɔ/, as in *height*, *house* /ˈhaɛt, ˈhaɔs/ [ˈhaɘʈ, ˈhaɷs]. In regional pronunciations, they can vary as far as [ᴀ, ʌ, ɑ, ɒ] &c for /aɛ/, and [æ, ɐ, ᴀ, ʌ, ɑ] &c for /aɔ/.

fig 8.6. Orograms of the vocoids of the 12 neutral British-English true monophthongs.

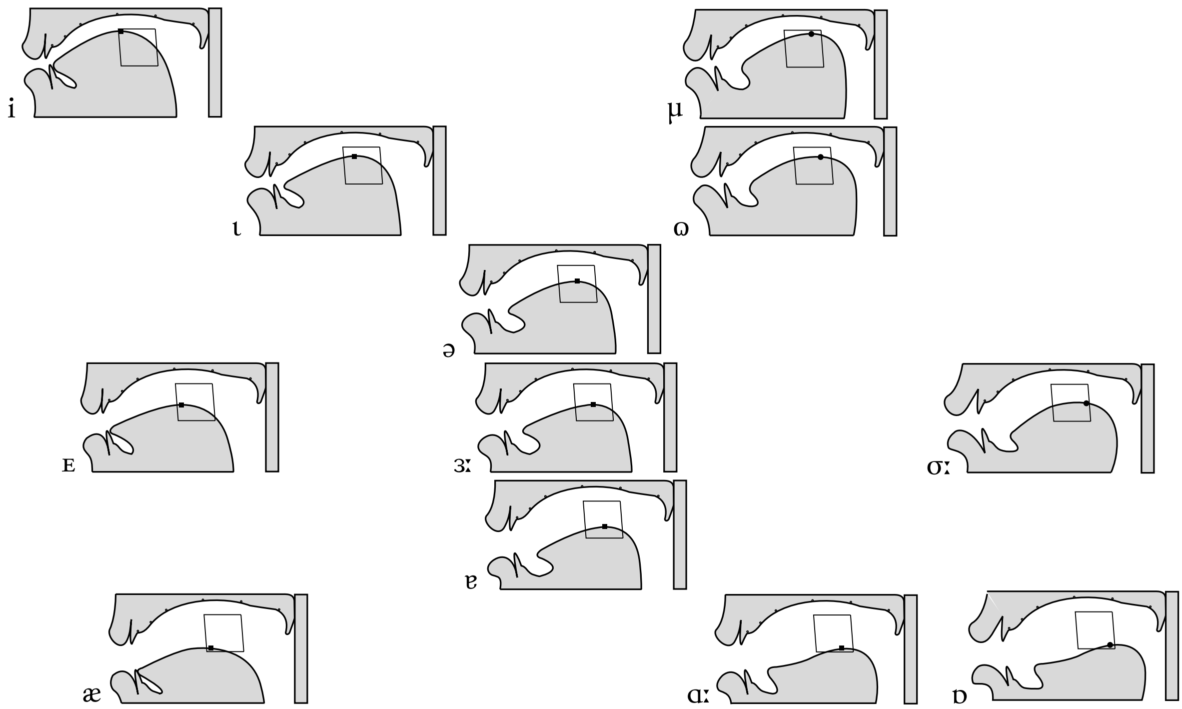
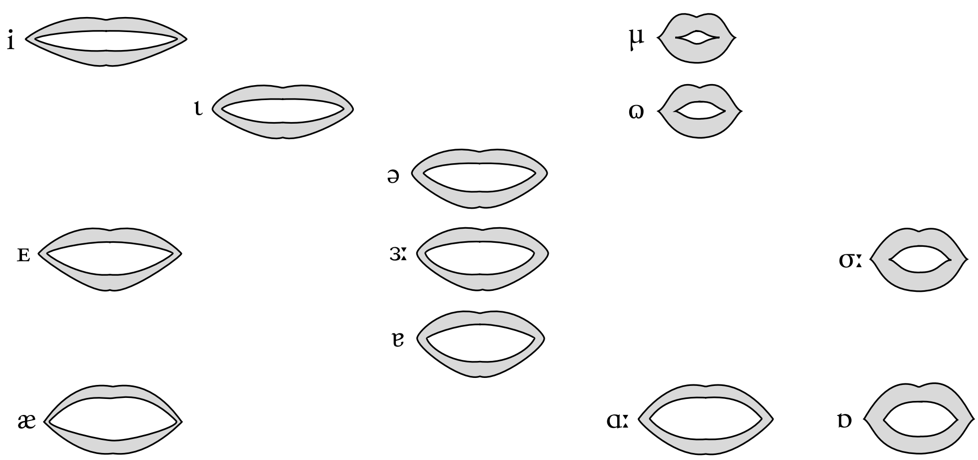


fig 8.7. Labiograms of the vocoids of the 12 neutral British-English true monophthongs.



The central location is fundamental, although it is not necessarily the most frequent or 'normal' one (just as the peripheral 'cardinal' locations of Jones were not the most common, either). Besides this, there is the possibility of shifting in a high–low direction, or in a front–back direction. Combinations are also possible, such as high–front, low–back, low–front, high–back.

While listening to recordings in order to analyze a particular language, it is definitely helpful to use diacritics of DISPLACEMENT, especially while making notes by hand. Thus, a point, [.], can be placed (or a double underlining [‗] as with contoids, § 9.5) generally underneath a vocoid to indicate (fairly) central position within the box [ẹ, ạ, ị, ỵ]. It would also be possible not to use any diacritic, considering the central position as the default one. For this approach to work, it is necessary for there to be consistency, so that later on, it will not become necessary to wonder whether the absence of a point underneath meant simply the refusal to take a firm position on the exact location of the vocoid (as could happen when indicating a mere opposition with other vocoid symbols, such as [e], with respect to [ɪ], or [ᴇ], or [ɘ]…).

The other diacritics indicate a direction of displacement, which is the direction in which the middle 'prong' is pointing: [˔, ˕; ˖, ˗; ˃, ˂; ˄, ˅] (here in opposing pairs). Thus the first denotes raising, while the second refers to lowering, as in [o̝, o̞]; the third indicates displacement forwards, while the fourth refers to backwards movement, as in [o̟, o̠]; the fifth denotes raising and fronting together, &c. They can also be combined: *two of the same diacritic symbol* (for example, [˖˖]) indicate a displacement all the way to the edge, or even slightly beyond, while a single diacritic, *placed within parentheses*, ([(˖)]), denotes a lesser degree of displacement.

For particular (descriptive or teaching) purposes, icons of the type ⊠, and ⊠, ⊠, ⊠, ⊠, and ⊠, ⊠, ⊠, ⊠, may be useful, in order to indicate the nine general positions within a particular box.

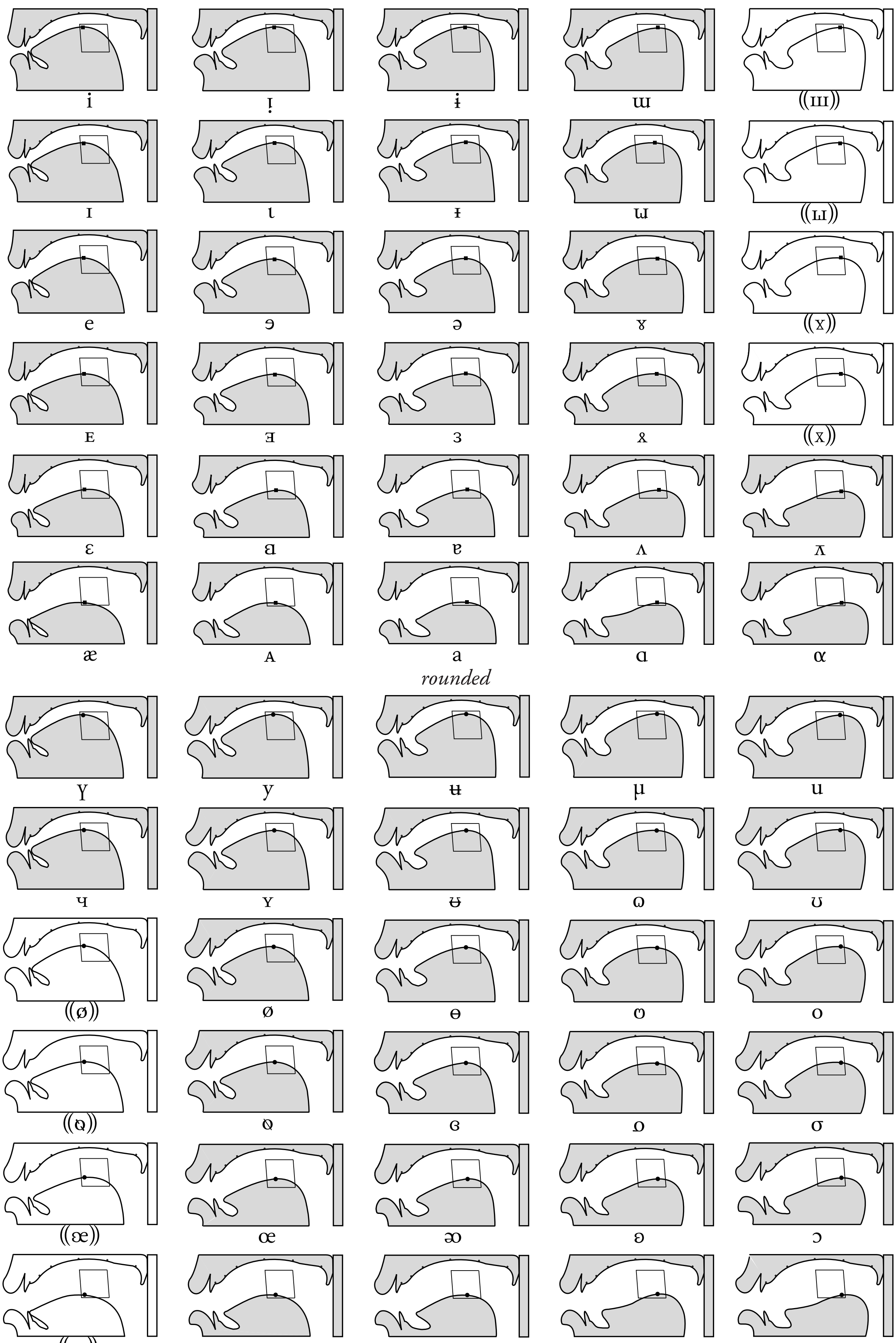
It is clear, however, that there are many more than nine positions actually possible – at least twenty or so per box, even continuing to simplify a bit. To give a round number, there are somewhere from 500 to 1000 possible vowel sounds, which are then representable by the 52 vocoids (although with different locations inside the vocogram). On the other hand, according to the language spoken, an average speaker typically only distinguishes 5 to 15 of these (even if the phonemes may be more, thanks to the addition of length).

8.12. But let us now move on to a consideration of all of the vocoid articulations. We will proceed vertically, according to places of articulation, starting with the more simple vocoids, namely those without lip rounding (*fig* 8.8, upper part). For the sake of completeness, the 'virtual' vocoids are also present – with no gray background – with their symbols placed in double parentheses. The lower part of *fig* 8.8 gives the rounded vowels (30 in all, too, four of which are in parentheses).

To begin, we should observe the figures carefully; we will then provide examples. As can be seen readily, all of them are different from one another! Vowel orograms should not be considered hurriedly, lest important details be missed. For each one, the reader should seek to arrive at a sufficient level of competence in kinesthesia, so that they can be articulated while the figures are being inspected.

fig 8.9 shows the labiograms of the different vocoids. The reader should note that the first column, that of front vowels, is articulated with *spread* lips: [i, ɪ, e, ᴇ, ɛ, æ]; all of the other unrounded vocoids have the lips in the *neutral* position. In the central column, we find the labiograms of the *half-rounded* vocoids, such as [i̯, ɑ̯].

While we are on the topic of rounding, we note that there are two different ƒ8.8. Vocoid orograms.



types of rounding. The more common one involves the addition of a certain amount of lip *protrusion* (*cf* *fig* 8.3 and *fig* 8.9), and is typical of the front-central rounded vocoids (such as [y]) as well as the back rounded ones (such as [u]). The other type is a sort of ‹*vertical*› rounding (as can be seen in *fig* 8.3 [*cf* *fig* 8.9, as well]). It is typical of front rounded vocoids (such as [ʏ]). Central rounded vocoids (such as [ʉ]) and back-central rounded ones (such as [µ]) can be articulated in either of the two ways, according to the language. For this reason, in the illustrations mentioned, these vocoids are placed in both categories (in brackets). In *fig* 8.9, the half-rounded vocoids also appear in brackets (and, in fact, they are not extremely common), while the 8 'virtual' vocoids are placed in double brackets.

It will not be superfluous to emphasize that the *offIPA* vocoids, located as they are in their 'potential' trapezoid, without true subdivisions and with only a meager number of symbols available, seem to have been 'forced' together due to an anxiety for generalizations. This organization is responsible for the (not unduly scientific) 'beliefs' that [y], in reality, is merely [i] with rounding (the vocoid we denote [ʏ]), and that [ɯ] is actually [u] without rounding (the vocoid we denote [ɯ]). Instead, phonetic reality shows that [y] is a front-*central* rounded vocoid, while [ɯ] is back-*central* (unrounded).

8.13. For the purpose of learning and rationally memorizing the value and location of all of the elements of our vocogram, we will proceed through the various symbols, explaining their origin as well when this is useful. We will begin with the symbols for the 18 Jonesian cardinal vowels, considering *fig* 8.3 (and relying upon the orograms already provided, as well). These symbols will be considered according to the conventions of use which have developed over the course of time – particularly the practice of denoting the most widely used and most frequent sounds with the most normal symbols. In fact, at this point, some of the cardinal symbols have ceased to represent the sound they (theoretically) had originally, and now denote the values that were more commonly attributed to them (often including more than one of our boxes), because of being commoner in the languages of the world.

As other symbols are added, it becomes necessary to maintain the connections between the new symbols and the old ones, within the limits posed by keeping them clearly distinct and by the necessity of allowing them to be (relatively) easily written, by hand as well.

Given that the Latin alphabet served as a starting point, it was natural for the five vowel letters to represent the most frequent and normal sounds: [i, e, a, o, u]; these are used by many languages in stressed and unstressed syllables. In order to indicate the most frequent variants of [e, a, o], it was decided, logically enough, to denote more open vocoids, with respect to [e, o], with the symbols [ɛ, ɔ] (and, in fact, these symbols are literally *open*). In Portuguese, German, Italian and many other languages, we encounter 'closed' phonemes /e, o/ and 'open' ones /ɛ, ɔ/. (This terminology refers to the relationships between the two *e*'s and the two *o*'s, not to the extreme points on the vocogram which are *high* and *low* – officially *close* and *open*.)

A timbre different from [a] was shown by a variant in 'cursive', which was then wisely 'straightened' and adapted to the type of character which is technically referred to as *roman*, or *plain*, or *non-italic*. The resulting character was [ɑ]. In the traditional pronunciation of French, it was important to distinguish between two different kinds of *a* sounds, a 'front' one and a 'back' one (but in reality, one is front-central, [ᴀ], and the other back-central, [ɑ]), although in modern pronunciation, the phonemic nature of the distinction has been done away with, because the second timbre has been eliminated. In neutral English, whether American or British, the front *a* is a truly front vocoid, [æ], in opposition to [ɑː]. (For English and French as well, in regional variants, or even in pronunciations widely used in the media, the actual realizations can be notably different, cf *HPr* Ch 2 & 4.)

8.14. Continuing to pass through the symbols, the grapheme *y* was used, very intelligently (and with the inspiration of some northern European languages), for the front-central rounded vocoid [y], found in French *flûte*, [y], or in German *über*, [yː]. This freed the alphabet, finally, from the handicap of previous 'phonetic alphabets' (and some later ones as well!), namely, the use of diacritics to denote TIMBRES, instead of MODIFICATIONS OF TIMBRES, as would be more than logical. For this reason, 'symbols' such as '/*ü*, *ö*, *ä*, *ë*, *ï*/' are absurd, without mentioning 'masterpieces' like '/*ọ̈̃́*/', in place of [ˈœ̃ː].

Taking the graphemes *ø*, *œ* from European alphabets as well, it was then possible to represent the other two front-central rounded vowels which are most commonly found, [ø, œ]: in French *bleu* /ø/, *œuf* /œ/, and in German *schön* /øː/, *löschen* /œ/. To these, a small capital version was added, for the open vocoid, [ɶ] (which is often omitted from tables and lists due to its rareness, or because it was thought to be absent from real languages).

In the back region, the unrounded vocoids theoretically corresponding to [u, o, ɔ] were denoted, in this case as well with quite positive results, by [ɯ, ɤ, ʌ]. In reality, rather than being 'back' vocoids (as they would be theoretically), they are *back-central*, given that in the back region it is difficult to produce unrounded vocoids (since they would sound rather similar, while requiring a greater effort).

The cardinal symbols become 18 in all, with the simple, but clever, addition of [ɨ, ʉ], for the high central vocoids.

8.15. The next additions involved other distinctions which were important for the relative openness of several vocoids already present. In these cases, small capitals were used (wisely adapted to the dimensions of lower-case characters, even if the difference, though real, was not obvious; however, *noblesse oblige!*).

In this way, the lower-high vowels [ɪ, ʏ, ʊ] were obtained, corresponding to [i, y, u] (even though, in place of [ɪ, ʊ], the optional variants [ɩ, ɷ] were frequently found; we use these last for other, similar values, as will be seen shortly). With this expansion of symbols (and, naturally, in accord with the actual timbres of the vocoids), [ɪ, ʏ, ʊ] represent well the sounds of neutral German in *List*, *fünf*, *Lust* /ˈlɪst, ˈfʏnf, ˈlʊst/. As it happens, [ʊ] is not a true small capital, (which would be '[ᴜ]', and this last is actually used by publishers who do not have the real symbol), but it is decidedly more conspicuous than the small capital, and also easier to write by hand.

The emaciated central area of the vocogram received three more elements, which are fundamental in British English, namely [ə, ɜ, ɐ], progressively opener (*ie* lower), as in *the murder* [ðəˈmɜ˞ɖɐ]. To these, [æ] was added, as in *hat* [ˈhæʈ]. As is well-known and as we have emphasized, this vocoid constitutes today the lower front limit of the modern scientific vocogram, even though the official trapezoid obstinately places '[a]' in this corner, while putting '[æ]' above it. The value of [ɐ] is clearly connected, in its shape as well, to that of our central [a]. In fact, if one were to use the official trapezoid rigorously, but rather blindly, [ɐ] would need to be used for Spanish or Italian *casa* (even for the stressed syllable!), since –among the few official symbols– [ɐ] is the one which is closer to the timbre in question. However, phonetics is an artistic, and also human, science and thus is capable of common sense (and of the possibility of expansion and adaptation), notwithstanding ridiculous and anachronistic refusals to move forward.

8.16. In the latest reform, three other vocoids have been added to the official trapezoid. One is the rounded vocoid corresponding to [ɜ], namely [ɞ] (which, appropriately, is similar to the unrounded symbol, while being closed off, given that the vocoid is rounded). This vocoid occurs, for example, in New-Zealand English, as in *fur* [ˈfɞː], while British English has [ˈfɜː]. (In the early periods of the reform, from 1989 to 1993, the symbol was mistakenly flipped horizontally – in place of [ɞ], there appeared '[ɵ]', which in our system *canIPA* is used with a different value.) Another symbol is [ɵ], which represents a rounded vocoid, as is logical from the shape, with the addition of the horizontal line characteristic of central high vocoids. We find an example in Dutch *lus* [ˈlɵs̩]. In our vocogram, this new symbol corresponds completely to the SCHWA (/ˈʃwɑː/) [ə], naturally with rounding.

Officially, the other new symbol, [ɘ], ought to represent the unrounded vocoid corresponding to [ɵ]. However, given that in the official trapezoid, [ə] is extremely vague and generic (which denotes, more than anything else, 'not being on the periphery', and can refer to fully 17 of our symbols, in transcriptions of different languages by different authors!), we prefer to give [ə] its more normal and frequent value, which is the value officially attributed to '[ɘ]'. In this way, we can reserve the front-central value (not just central, but certainly higher-mid) for [ɘ], which, given its relationships of symmetry with other symbols, fits well between [e] and [ə]. It is used, very usefully, for the second element in the English diphthong of words like *fly* [ˈfla˞ɘ] (rather than '/flaɪ/'; or '/flai/', which was very commonly used in a still earlier period).

canIPA vocoids

8.17. At this point, we move on to additional vocoid symbols, found in *canIPA*. These represent quite precise vocoids which are in no way secondary to those already treated. Beginning, again, with the *unrounded* ones, we have, between [i] and [ɨ], the high front-central vocoid, [ɪ̣], whose shape is clearly linked to that of

[i], but with a bit of difference. This vocoid occurs in Somali: *inan* [_ɪ̣·nan], or also in the Italian dialect of Bologna: *finîr* [fɪ̣ˈnɪ̣ir]. Below [ɪ̣], we find [ɩ], which is very common in English, for example in *lisp* [ˈlɩsp]. This symbol resembles the lower part of [e] (as is logical, given that the vocoid is similar to [e, ɘ] from an auditory point of view).

In the central box of the lower-high vocoids, we find the small capital version of [ɨ], namely [ᵻ], as in German: *bitte* [ˈb̥ɪtᵻ], which fits in well into the series of [ɪ, ʏ, ʊ]. At this point, however, the visual pattern of small capitals (which had to be interrupted earlier by [ɩ]), continues, to a certain extent, with [ɯ], clearly related to [ɯ], given that it is the lowered variant of this last. This vocoid occurs in Turkish: *karı* [kʌˈɾɯ].

A small-capital *e* (adapted perfectly, as always, to the correct dimensions) provides an ideal way to fill the urgent need for a front phone, halfway between [e] and [ɛ], which is therefore [ᴇ], as in English: *yes* [ˈjᴇs].

8.18. The mirror image of [ᴇ], that is [ɜ], can certainly be linked up to the parallelism between [e, ɘ], as can be seen from the vocogram. An example can be found in Mandarin Chinese: *rén* [˩ʐɜn]. The higher-low front-central vocoid, [ɑ], maintains a clear relationship with [ɛ], while naturally remaining distinct from it. We find this vocoid in Arabic: *walad* [ˈwɑlɑd]. The last element of this series is [ᴀ], as in French: *papa* [pᴀˈpᴀ], or Mandarin Chinese: *wān* [˥wᴀn]. Frankly, it might seem, given the general pattern of the small capitals used elsewhere, that it would make more sense to use this symbol for the value we denote here by [a], thereby forming a (perhaps more 'harmonious') series '[a, ᴀ, ɑ]'. However, as we have already mentioned, the central value is for *a* by far the most normal and frequent one, in the languages of the world. For this reason, the order [ᴀ, a, ɑ] is fully legitimate, and logical as well. The back-central lower mid vocoid, [ᴧ], clearly resembles both [ɤ] and [ʌ], which are on either side of it, vertically. We find this vocoid, for example, in Mandarin: *fēng* [˥fᴧɴ], and in Russian: *vodka* (*водка*) [ˈvɷσtkᴧ]. We represent the value theoretically denoted by '[ʌ]', that is, higher-low back, with the vocoid [ʌ̄], whose shape is similar to that of [ʌ] , given that the sounds are similar, though not identical. We encounter this vocoid in Dutch: *coud* [ˈkʌ̄ʊt], or in the Tyrolese dialect spoken in Alto Adige (in northeastern Italy): *wasser* [ˈßɒˢsʌ̄].

The actual cardinal value of '[ɑ]', in the trapezoid and in the records provided by Jones, is the rarely occurring [α], which is found in Dutch: *Amsterdam* [ˌαmṣtɾ̥ˈdαm]. Instead, we use the symbol [ɑ], more logically, for the value found, for example, in British English: *car* [ˈkhɑː], in American English: *car* [ˈkhɑːɹ], and in very many other languages. The link between [α] and [ɑ] is made even stronger by the fact that certain publishers, due to typographical limitations, would substitute [ɑ] with [α].

8.19. We now move on to the *rounded* vocoids, pronounced with rounding of the lips. We mention again that the theoretical '[y, ø, œ, ɶ]' are in reality, front-central rounded vocoids; thus, it is appropriate to leave them with the values they have always had in practice. All that is left is to complete the sequence (including [ʏ]), by adding the intermediate [ɵ], similar to [ø], but not identical, as with the other flipped or rotated symbols. We find it in French: *seulement* [sɷlˈmɒ̃].

If we move on to the true front rounded vocoids, we find only the two close ones, [ʏ, ɥ], as in Swedish: *ny* [ˈnɥʏ] (/ˈnyy/). The shapes, irrespective of any graphemic value for the second symbol, resemble one another (as lower-case and small capital, respectively), but are also similar to the nearby [y, ʏ]. It is therefore more useful and 'natural' to consider the more frequent ([y, ʏ]) as more 'canonical', and to derive [ʏ, ɥ] from these (instead of the other way round), by moving the tongue forward by an average of a couple of millimeters.

Moving on to the central rounded vocoids, it is logical to fill the gap between [ʉ, ɵ] by adding [ɵ], which can be found in Icelandic: *unna* [ˈʔɵnⁿa]. Just as motivated, in its phonic value as well, is the use of [ɞ] for the higher-low vocoid in the series, as in Parisian and mediatic French: *bonne* [ˈbɞn], or in Swedish: *dörr* [ˈdɞɾ]. The low vocoid, [ɐ] sounds like an [a] with a sort of darkening added. This is caused by the rounding, which is necessarily not very strong, given that the vocoid is (so) low. The vocoid occurs in the dialect of Bari (in southern Italy): *sante* [ˈsɐʌnd̥ə]. For these reasons, the connection with [a] is fairly solid and natural. Our symbol is preferable to the more bulky '[ɞ]', decidedly difficult to write by hand (the reader should try, if in doubt!), even though this last might seem more 'logical', in a series.

8.20. In the back rounded series, the addition of [σ] deserves some comment. It was added to fill in the lower-mid position, as in the other series. However, the shape of [o] cannot be effectively modified by rotations or reflections, nor by creating a small capital. For this reason, the only way to maintain the connection with the normal letter *o* was to use the Greek letter sigma (*σ*, disregarding its completely different value in Greek). Therefore, [σ] represents the timbre halfway between [o, ɔ], as found in English: *pour*, [ˈphσː(ɹ)] ([ɹ] is for the American pronunciation), or in Spanish: *moda* [ˈmσˑδa].

All of the back-central rounded series, [µ, ɷ, ɵ, ɒ, ɘ, ɒ], is nothing other than a modification of the back rounded series, and (some more, some less) all of the symbols resemble the others. For example, [µ] and [u]; [ɷ] resembles the corresponding unrounded vocoid ([ɯ], with the same location) as well, not just [ʊ]; [ɵ] resembles both [ɷ] and [o]; [ɒ] is derived from [σ], as well, by 180° rotation; finally, both [ɘ] and [ɒ] resemble, respectively [ɔ] and [ɒ], with modifications chosen from among the few still possible at this point.

Although phonemic transcriptions (but also those which seek to be phonetic) of French, by using /u, o, ɔ/, create the idea that this language has vocoids similar to those of Portuguese, or Italian, or German, the reality is quite different. In fact, in French (in 'modern' pronunciation), we find examples of all six of the back-central rounded vocoids, as in *pourtour* [pɷʁ̥ˈtµːʁ̥], *monôme* [mɒˈnɵːm], *bonne* [ˈbɘn], *cent* [ˈsɒ̃]. In English, the symbol [ɷ] is necessary in words such as *look* [ˈlɷk].

In Tuscany as well, the Italian phonemes /u, o, ɔ/ are actually pronounced [µ, ɵ, ɘ], at least as the basic form, with forwards or backwards diphthongizations possible in certain areas (as can be seen from the Tuscan phonosyntheses, for Florence, Siena, Pisa, Livorno/Leghorn, and Piombino, in Ꝕ 16). Here are a few examples in the pronunciation of Florence: *luna*, *dopo*, *modi* [ˈlµːnʌ, ˈdɵːφɵ, ˈmɘːdi].

8.21. Now, keeping in mind the 52 orograms of *fig* 8.8 (placed at the end as an appendix for purposes of referral and checking, and with the 8 currently 'theoretical' ones as well), we will present briefly the symbols together with languages using these vocoids. The examples are not complete, since for now it is sufficient to run through the vowel phones quickly. In Ꝕ 15-23, the phonosyntheses of 320 tongues (*ie* languages, dialects, and variants will be given). Further examples can be found there, as well as reliable information for beginning a rigorous study. *HPr* gives systematic treatments of the twelve languages there considered (together with variants of these): English, Italian, French, German, Spanish, Portuguese, Russian, Arabic, Hindi, Chinese, Japanese, and Esperanto.

Unrounded vocoids:

[i] *vivir* Spanish
[ɪ] *Kind* German
[e] *sete* [ˈseːte] Italian
[ᴇ] *settecento* [ˌsᴇt-] Italian
[ɛ] *sette* [ˈsɛtː-] Italian
[æ] *hat* English

[ɪ̣] *inan* [_ɪ̣·nan] Somali
[ɩ] *bit* English
[ɘ] *bite* [ˈbaɘʈ] English
[ɜ] *bèn* Mandarin Chinese
[ɐ] *walad* [ˈwɐlɐd] Arabic
[ᴀ] *lac* French

[ɨ] *ty* (= *ты*) Russian
[ᵻ] *bitte* [-tᵻ] German
[ə] *to be* [ʈə-] English
[ɜ] *fur* British English
[ɐ] *lover* [ˈlɐvɐ] British English
[a] *datar* Spanish

[ɯ] *zì* Mandarin Chinese
[ɯ] *hammock* [-ɯk] English
[ɤ] *cè* Mandarin Chinese
[ᴧ] *céng* Mandarin Chinese
[ʌ] *love* American English
[ɑ] *hot* American English

[ᴧ] *paus* [ˈpᴧʊʂ] Dutch
[α] *kans* Dutch

Rounded vocoids:

[ʏ] *ny* [ˈnʏː] Norwegian
[ɥ] *ny* [ˈnɥʏ] Swedish

[y] *lune* French
[ʏ] *Glück* German
[ø] *deux* French
[ɵ] *sœurette* [sɵ-] French
[œ] *sœur* [ˈsœːʁ] French
[ɶ] *sœur* [ˈsɶœɾ] Canadian French

[ʉ] *null* Norwegian
[ʉ] *nul* Flemish
[ɵ] *nul* Dutch
[ɞ] *fur* New Zealand English
[ɞ] *dörr* Swedish
[ʚ] *sante* [ˈsʚʌnd̥ə] Barese (SE Italy)

[µ] *vous* French
[ɷ] *look* English
[ʊ] *beau* French
[ɒ] *bonnet* [bɒ-] French
[ɘ] *bonne* French
[ɒ] *ân* [ˈʔɒːn] Persian

[u] *susurro* Spanish
[ʊ] *und* German
[o] *sotto* [ˈsotːto] Italian
[σ] *ottocento* [ˌσt-] Italian
[ɔ] *otto* [ˈɔtː-] Italian
[ɒ] *hot* British English

We will proceed according to places of articulation, rather than by manner – therefore, vertically, along the columns. (Here we give as well, in parentheses, the symbols for possible vocoids in the eight boxes which are currently empty.) We have, therefore: *front* [i, ɪ, e, ᴇ, ɛ, æ], *front rounded* [ʏ, ɥ, (ø, ɷ, œ, ɶ)], *front-central* [ị, ɩ, ɘ, ɜ, ɐ, ᴀ], *front-central rounded* [y, ʏ, ø, ɷ, œ, ɶ], *central* [ɨ, ᵻ, ə, ɜ, ɐ, a], *central rounded* [ʉ, ᵾ, ɵ, ɞ, ɞ, ɞ], *back-central* [ɯ, ɯ, ɤ, ɤ, ʌ, ɑ], *back-central rounded* [µ, ɷ, ʊ, ɒ, ɘ, ɒ], *back* [(ɯ, ɯ, ɤ, ɤ), ʌ, ɑ], *back rounded* [u, ʊ, o, ɔ, ɔ, ɒ].

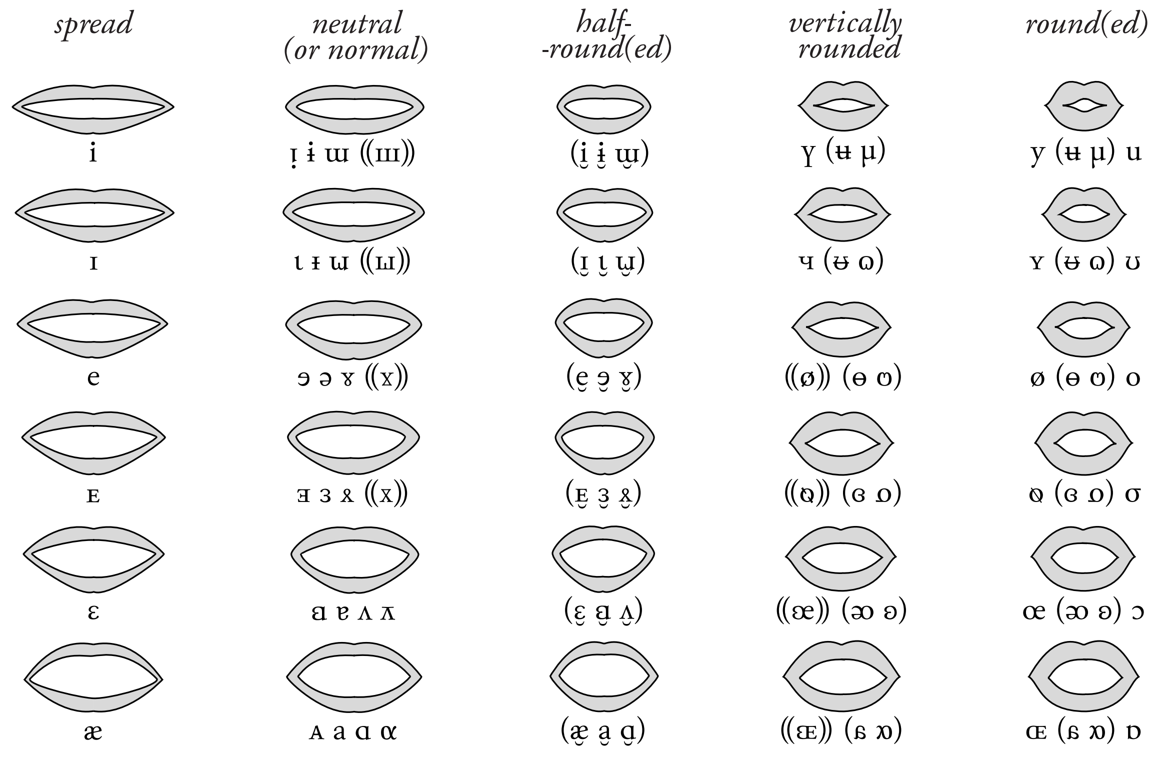
At any rate, it is naturally also useful to produce the horizontal series (by manners), as an exercise: *high* [i, ị, ɨ, ɯ, (ɯ)], [ʏ, y, ʉ, µ, u], *lower-high* [ɪ, ɩ, ᵻ, ɯ, (ɯ)], [ɥ, ʏ, ᵾ, ɷ, ʊ], *higher-mid* [e, ɘ, ə, ɤ, (ɤ)], [(ø), ø, ɵ, ʊ, o], *lower-mid* [ᴇ, ɜ, ɜ, ɤ, (ɤ)], [(ɷ), ɷ, ɞ, ɒ, ɔ], *higher-low* [ɛ, ɐ, ɐ, ʌ, ʌ], [(œ), œ, ɞ, ɘ, ɔ], *low* [æ, ᴀ, a, ɑ, ɑ], [(ɶ), ɶ, ɞ, ɒ, ɒ].

8.22. The phonetic method makes it possible to conquer (with a bit of practice, that is, getting into the spirit of the method) the sounds of other languages and dialects, by starting from one's own. For this reason, we will now observe at least the *orograms* of the *twelve* vocoids which are the realizations of the actual monophthongal phonemes of present-day neutral British English (fig 8.6, with unstressed /i, u/, as in *react*, *influenza*), in order to provide an objective starting point (even though almost every native speaker has a regional pronunciation, at least to some degree). We give *labiograms* as well (fig 8.7, without showing the teeth), which are more functional and to the point, since they allow the viewer to concentrate on the essential elements without distractions.

While, for the languages indicated in § 8.21, the reader is referred to the *phonosyntheses* or to *HPr*, where they are dealt with, for the somewhat simplified *vocograms* of British English, we direct the reader back to fig 6.1.2 (and to Ch 2 of *HPr*, for a fuller treatment of various English accents, with variants).

And now (cf 8.8), let us examine the 52 *orograms* necessary for describing ade-

fig 8.9. Labiograms of the vocoids, including distinct (and intermediate) states.



quately the languages and dialects of the world (with the 8 theoretical ones added as usual). It would naturally be helpful to look at the *vocograms* in the various phonosyntheses (and in *HPr*), and not just for study, but also to satisfy a simple (but legitimate, and healthy) scientific and human curiosity.

fig 8.10. Labio- and orograms of all the vocoids, including distinct (and intermediate) states.

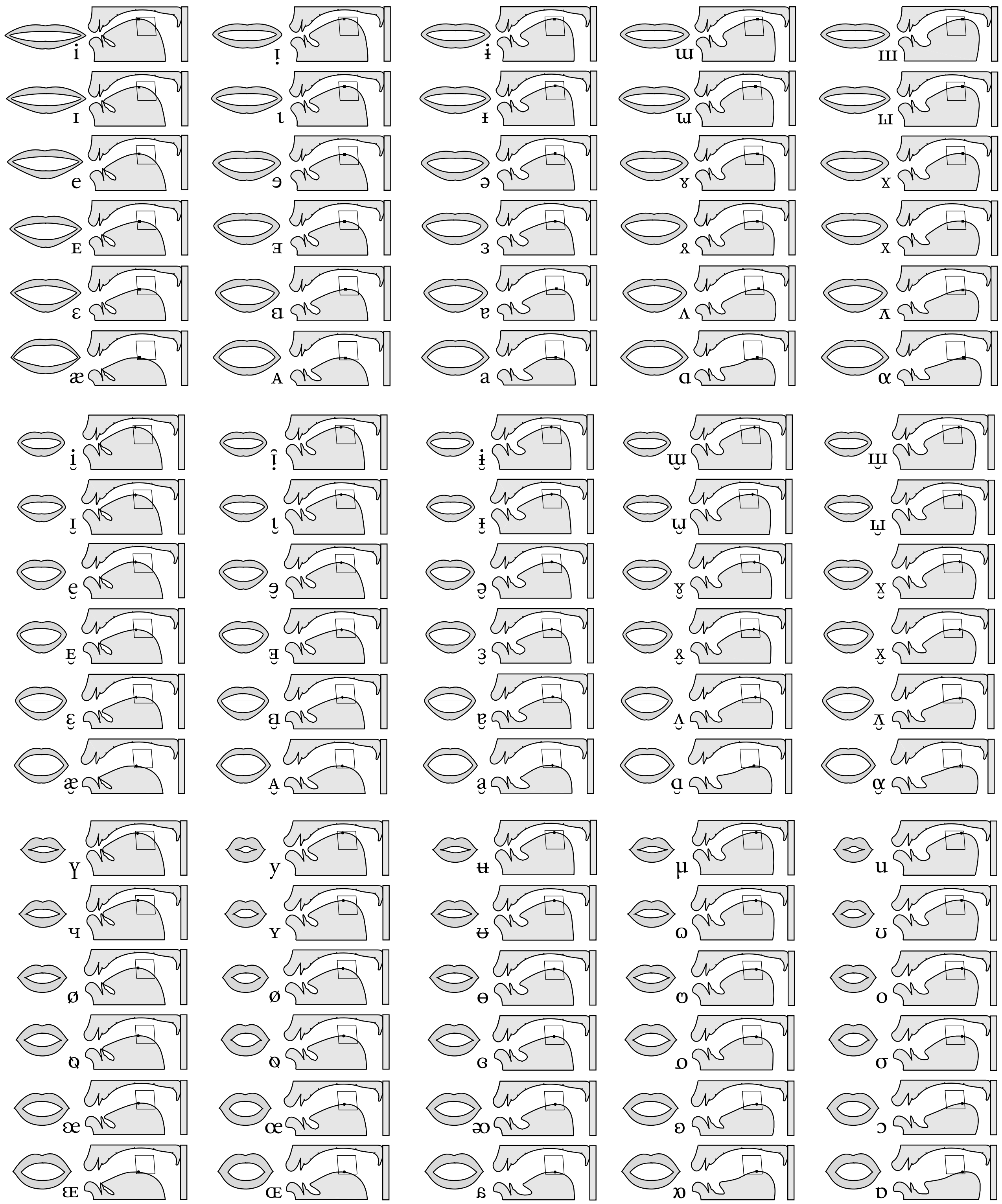


fig 8.9 gives *labiograms* for the vocoids, many of which naturally coincide (since different vocoids can have the same lip position). It will be useful to consider all of them carefully, proceeding with kinesthesia as necessary in order to produce each articulation, working from the more familiar to the less common ones. There are 5 types of lip position, with 2 which are more normal (*ie* neutral and rounded), and 3 complementary ones (*ie* spread, half-rounded, and vertically rounded).

For the sake of greater completeness, we give in *fig* 8.10 all of the possible vocoids, including both the 8 potential ones and also the 30 with intermediate lip position (halfway between neutral and rounded), that is, half-rounded (shown by the appropriate diacritic).

Articulatory practice

8.23. Once the most common (or familiar, for a given person) vocoids have been located in the vocogram, it is necessary to find out their true positions, not just what one thinks they ought to be. It is also necessary to be able to pass from one sound to another, initially starting with the more familiar ones (as always).

To use kinesthesia to feel the different positions of the tongue and of the lips, it is singularly useful to articulate the sounds slowly, with great patience and care. It is particularly important to learn to articulate them *silently* – without letting air out and without 'voicing', or in other words without letting the vocal folds vibrate, even in the reduced manner present during a whisper. As it happens, voicing covers over and masks the essential movements, thereby distracting from the full sensation of kinesthesia. Whispering (voiceless lenis phonation) will be used later, as a compromise between the useful artifice of silent articulation and normal phonation of real speech.

It is only necessary to make a single attempt in order to see how our ability to perceive movements of the tongue and lips becomes incredibly expanded, if we concentrate only on the sounds, without any sort of phonation. (Of course, this does not mean that we should stop breathing.)

This is the practice of *silent introspection*, and it helps us to discover many unexpected and unsuspectable things. It is possible to add, instead of exhalation, a voiceless *inhalation* (performed in a noiseless way). In fact, if we articulate a phone (whether a vowel or consonant, but required to be *continuous*, *ie* without occlusion), and then inhale while maintaining the position of the phone, we become better able to perceive the point of articulation, because we are aided by the sensation of breeze caused by the incoming air. In the case of constrictive contoids, this sensation is naturally even more evident.

In the case of vocoids, one should try to practice pronouncing phones which are between those already known (including new ones that have already been learned well). Here again, silent introspection is a good method, in alternation with inhalation, whispering, and full voicing.

It is necessary to reach the point (at the beginning, with the help of a handheld mirror) where one is capable of feeling fully all of the *movements* of the *lips*, the *tongue*, and the *jaw*.

8.24. If we use neutral British English as a starting point, and continue to make reference to the general vocograms (*fig* 8.3 & *fig* 8.8-9), it will be possible to learn to produce phones which are near [ɩ] = [ɪ, ɪ̵], or [ɪ̣, ɘ]; near [ɷ] = [ʊ, ʊ̵], or [µ, ɵ]; near [ᴇ] = [e, ɛ; ɜ]; near [ɔ] = [o, ɔ; ɒ]; near [æ] = [ɛ, ɑ, ᴀ]; near [ɒ] = [ɔ, ɵ, ɒ]; near [ɑ] = [a, ʌ, ɑ]; near [ɐ] = [a, ɜ] or [ʌ, ɐ]; near [ə] = [ɪ̵, ɜ], or [ə, ɯ]; near [ɜ] = [ə, ɐ], or [ɜ, ɤ]. Lip rounding can be added, while taking care not to change the position of the tongue, in cases like: [ɩ] → [ʏ]; [ə] → [ɵ]; [ɜ] → [ɞ], &c. Rounding can also be taken away, such as in: [ɷ] → [ɯ]; [ɒ] → [ɑ], &c.

Then, one can isolate the members which form the diphthongs of British English: [ɪi, ᴇɪ, aɘ, ɔɘ, aɒ, ɜɷ, µu], [i, ɪ, ᴇ, a, ɘ, ɜ; ɔ, ɒ, ɷ, µ, u], and then change their lip positions: [y, ɥ, ɵ, ɞ, ø, ɞ; ɤ, ɤ, ɯ, ɯ, ɯ].

If we have already learned, or *phonetically felt* [y, ø, œ], or [ɯ, ɤ, ʌ], perhaps we instinctively articulate them as front-central rounded vocoids (and not *front* rounded ones, [y, ø, œ]) and as back-central ones (not *back* unrounded ones, [ɯ, ɤ, ʌ]), respectively.

In the context of this exercise, it would be useful to succeed in producing even vocoids not currently found in any analyzed language, since the result would be progress in disciplining one's articulatory movements. At the same time, it is naturally clear that in languages such as French and German, front rounded vocoids ([y, ɥ, ø, ɵ, œ]) should not be accepted in place of [y, ʏ, ø, ɵ, œ]; just as [ɯ, ɯ, ɤ, ɤ, ʌ] would not be appropriate in languages (Asian or otherwise), which have [ɯ, ɯ, ɤ, ɤ, ʌ].

Other exercises, which should also be carried out calmly and patiently (and in the beginning in silence, following one's progress carefully on the vocograms), involve producing homogeneous and gradual sequences of vocoids (at the initial, perhaps incomplete ones). Thus, it is possible to move along the columns, from the top to the bottom (and vice versa), as well as horizontally, from front to back (and vice versa). We have: [i, ɪ, e, ɘ, ɛ, æ], [u, ʊ, o, ɔ, ɔ, ɒ], [y, ʏ, ø, ɵ, œ, ɶ], [ɯ, ɯ, ɤ, ɤ, ʌ, ɑ], &c. Also: [æ, ɛ, ᴇ, e, ɪ, i], [ɒ, ɔ, ɔ, o, ʊ, u], [ɶ, œ, ɵ, ø, ʏ, y], [ɑ, ʌ, ɤ, ɤ, ɯ, ɯ], &c. And still: [i, ɪ̣, ɨ, ɯ, (ɯ)], [ɪ, ɩ, ɪ̵, ɯ, (ɯ)], [e, ɘ, ə, ɤ, (ɤ)], [ᴇ, ɜ, ɜ, ɤ, (ɤ)], [ɛ, ɑ, ɐ, ʌ, ʌ], [æ, ᴀ, a, ɑ, ɑ] (and vice versa).

It is possible to do the exercises along diagonal movements, even though this is a bit trickier, since two parameters change each time instead of just one. For example: [i, ɩ, ɘ, ɤ, ʌ], [ɪ, ɘ, ɜ, ʌ, ɑ], or: [y, ʏ, ɵ, ɒ, ɔ], [ɥ, ø, ɞ, ɵ, ɒ], &c. An exercise such as: [i, ʏ, ɘ, ɒ, ʌ], [ɪ, ø, ɜ, ɵ, ɑ] would be yet more complicated, but certainly not useless; here changes in all three parameters occur together.

Another exercise, which is quite a bit less difficult, but certainly not useless, involves alternating the two fundamental positions of the lips, while moving vertically and horizontally (in the two directions; and, as always, in silence at the outset): [i → y], [ɪ → ɥ]; [ɨ → ʉ]; [ɪ̣ → y], [ɩ → ʏ], [ɘ → ø], [ɜ → ɵ], [ɐ → œ]; [ɯ → µ], [ɯ → ɷ], [ɤ → ɵ], [ɤ → ɒ], [ʌ → ɵ], [ɑ → ɒ]; and [ɒ → ɑ], [ɵ → ʌ], [ɒ → ɤ], [ɵ → ɤ], [ɷ → ɯ], [µ → ɯ]; [œ → ɐ], [ɵ → ɜ], [ø → ɘ], [ʏ → ɩ], [y → ɪ̣]; [ɥ → ɪ], [y → i]; [ʉ → ɨ], &c. Clearly, checking the position of the lips and of the tongue (when possible), in a mirror, can be a great help.

In the case of the lips, however, it is certainly practical to start with the vocoids of one's own language, even if not a neutral variety. From this point, rounding can be taken away (or added, depending on the case), as we have already seen above. And still more exercises can be imagined...

8.25. There are various quantitative dimensions associated with the articulations of vocoids: the opening of the jaw with respect to the front teeth, the distance from the palate to the back of the tongue, as well as the distance between the lips in the case of rounded and unrounded vocoids. We can give average measure ments in these cases, to be found in *fig* 8.11 (in correlation with the six adjoining bands of *fig* 8.3).

But, on the other hand, it is apparent that we can pronounce [i, ɪ, ɩ, ɘ, ᴇ, æ, a, ɐ, ɜ, ə, ɑ; ɒ, ɑ, ɵ, ɷ, ɥ, u] fairly clearly, both with our teeth together, as well as with two fingers placed between the teeth, to create an artificial opening of at least 30 mm. In fact, the mouth uses various compensatory adjustments to continue to speak in a satisfactorily comprehensible way.

It is sufficient to remember that we generally are understood even when speaking (bad-manneredly) with food in our mouth, or (more tolerably) while sucking on a candy. The mouth uses appropriate adjustments also when certain consonants are found near the vowels. In order to produce the grooved consonants /s, ʃ/, as in *sassy*, *shush!* [ˈsæsi; ˈʃɐʃ, ˈʃʌʃ], or in Italian *sasso* and *Sciascia* [ˈsasːso, ˈʃaʃːʃa], there has to be very little jaw opening – in fact, the teeth are quite close together (as can be seen in *fig* 6.12 & *fig* 9.1 as well). Now, in order to produce [s, ʃ] with an [æ, a] in the middle, it is natural for the [æ, a] to become adapted to these circumstances, by being pronounced with less opening (as can be easily seen with a handheld mirror).

Naturally, the physical structure (of the articulatory apparatus) of the speaker makes the picture more varied, as we move from the average case to particular ones. A small child and a big man almost 7 ft tall will have correspondingly different measurements, which can be different (smaller for the child, bigger for the man) by as much as 50%. This is without considering other communicative variables – if a person yells in anger, or two lovers speak softly together, the configuration of the phonoarticulatory apparatus changes radically, and this change is also due to the paraphonic characteristics which are added (*cf* Ch 14).

Human language is so complex and organized, but at the same time adaptive, that any 'speaking' machine (both for encoding and, especially, for decoding messages) remains far away from being convincing, or even from being able to communicate effectively. This is true even without taking into account the more complicated and remarkable semantic and conceptual aspect of the problem.

fig 8.11. Average measurements for the different vocoids.

vocoids	*lips, for rounded V*	*lips, for un-rounded V*	*between the teeth*	*from palate to tongue*	*reference to the boxes*
high	4 mm	6 mm	4 mm	6 mm	5-7 mm
lower-high	6 mm	9 mm	5 mm	8 mm	7-9 mm
higher-mid	8 mm	12 mm	6 mm	10 mm	9-11 mm
lower-mid	10 mm	15 mm	7 mm	12 mm	11-13 mm
higher-low	12 mm	18 mm	8 mm	14 mm	13-15 mm
low	14 mm	21 mm	9 mm	16 mm	15-17 mm

Diphthongs: one phoneme or two?

8.26. The question of whether diphthongs should be considered *mono*-phonemic or *bi*-phonemic is easily resolved by considering the facts of the matter, not just theoretically, but according to practical phonemics.

Beforehand, we observe that it is appropriate to use the Latin prefix (*bi-*) instead of the Greek one (*di-*) – even though the opposition is with *mono-* (Greek). The reason is to avoid uncertainties and ambiguities with related terms, such as *diphonic*, which refers to pairs of phone(me)s with the same articulation (in place and manner), but with different sorts of phonation: *eg* [p, b] /p, b/.

The other similar term, but only lexically, is *diaphonemic*, which refers to functional entities belonging to a given system, but showing differences with regard to accents. In a single language, it is frequently important to differentiate social or geographical accents. This occurs, for example, in the case of British and American English – from a diaphonemic transcription such as /ˈgɔʊ, ˈsʊup, ˈhʌt, ˈlæˑst, ˈlɒˑst, ˈhəˑɹi, ˈkɑːɹ̣, ˈbɛṭəɹ̣, ˈnjʊu/ &c (*go*, *soup*, *hut*, *last*, *lost*, *hurry*, *car*, *better*, *new*), it is then possible to derive the British phonetic transcription ([ˈgɜˑɷ, ˈsʉup, ˈhɐʈ, ˈlɑˑsʈ, ˈlɒsʈ, ˈhɐɻi, ˈkhɑː, ˈbᴇʈɐ, ˈnjʉˑu]), and the American one ([ˈgɵˑɷ, ˈsʊup, ˈhʌʈ, ˈlæsʈ, ˈlɔˑsʈ, ˈhɟ̍i, ˈkhɑːɹ, ˈbᴇɽɟ̍, ˈnʊˑu]).

In Italian, as in Spanish and many other languages, diphthongs are sequences, which are also as such in writing, by combining the normal symbols which are available: they are, consequently, *biphonemic* sequences. These sequences are formed by simply combining the various vowel phonemes, with their normal realizations (subject only to certain limitations on which combinations are possible, due to historical and contingent reasons). The most frequent Italian diphthongs (the true diphthongs, correctly excluding sequences of /CV/, as in /jɛ, wɔ, ja, wa/, *cf* § 5.2-3) are: /ai, ia, ie, io, au/, followed by: /ɛa, ɛe, ɛi, ɛo, ɔi/, and: /ɛu, eu, ei, oi/. The diphthongs /ae, ɔa, ɔe, ea, ua, ue, ao, ɔo, eo, oa/ are decidedly less frequent, while /oo, ui, iu, ii, ee, aa/ are still rarer. If we do not restrict ourselves to words, but count phrases and sentences as well, Italian has examples of all phonic diphthongs possible, including /ɔu, ou, uu/ (*cf* § 5.1.2-3 of *MᵃPI*).

We will give only a few examples, from the most to the least common: *partirai*, *fattoria* /partiˈrai, fattoˈria/ [ˌpaɾtiˈraˑi, ˌfattoˈriˑa] (both with three syllables), *sono urgenti* /sonourˈʤɛnti/ [ˌsonourˈʤɛnːti] (sequence of four syllables).

The choice of whether to indicate diphthongs explicitly or not depends naturally on functional and statistical factors, not just distributional and structural ones.

Thus, in Italian (and in similar languages, such as Spanish and Portuguese, &c), it is normally possible to avoid making lists of all the diphthongs (or vowel sequences) possible. Equally, one generally does not make lists of all of the consonant sequences, among other reasons, because it would not be easy to be certain of giving really complete lists (or tables). The only way to be sure of the results would be to manage to consider all the scientific, technical, and rare words, while including only 'official' words, leaving out connected utterances.

8.27. The Germanic languages, instead, have systematic inventories of diphthongs, even though the orthographies are normally not so systematic, often presenting multiple ways of writing restricted and recognizable phonemic entities (for reasons having to do with the historical evolution of languages).

For example, within words in English, we have the following diphthongs: /ɪi, ɛɪ, aɛ, aɔ, ɔʊ, ʊu, ɔɛ/ (in diaphonemic transcription, excluding, for now, cases like *hear*, *care*, *hears*, *cares*, *hearing*, *caring* /ˈhɪəɹ̣, ˈkɛəɹ̣; ˈhɪəɹ̣z, ˈkɛəɹ̣z; ˈhɪə̣ɹɪŋ, ˈkɛə̣ɹɪŋ/, in order to avoid complicating excessively our development). These diphthongs are clearly *mono-phonemic*, first of all because they are paradigmatically in opposition both among themselves, and with simple /V/, as in: *leak* /ˈlɪik/, *lake* /ˈlɛɪk/, *like* /ˈlaɛk/, *Luke* /ˈlʊuk/, *look* /ˈlʊk/, *lick* /ˈlɪk/, *lack* /ˈlæk/, *lock* /ˈlɒk/, *luck* /ˈlʌk/.

Secondly, they are mono-phonemic also because their phonetic *realization* is not derived from the individual symbols within each diphthong, but globally. In fact, we have (where the slashes are used to separate British and American pronunciations): [ˈlɪik, ˈlᴇɪk, ˈlaɘk, ˈlμuk/ˈlʊuk, ˈlɷk, ˈlɩk, ˈlæk, ˈlɒk/ˈlɑk, ˈlɐk/ˈlʌk]. If we should go on to consider other English accents (such as the other nine given in *HPr* and their variants), the phenomenon would become even clearer, as many variations are encountered which depart considerably from the (dia)phonemic representation (*cf* the examples given in § 1.5).

Moreover, in English it is not possible to find examples of single segments or symbols, such as /a, ɔ/, but only /ɑː, ɔː/, unless we should go back to obsolete notations, such as /a, aː, ɔ, ai, au/ for /æ, ɑː, ɒ, aɛ, aɔ/. The last two of these are still given today as /aɪ, aʊ/, even though the real and normal articulation is [aɘ, aɵ]; but this is the maximum amount of precision and refinement to be found, for the time being, in international printed works. In the chapter on English in *HPr*, our transcriptions will naturally be like those shown here.

We will briefly, as an example, look into the case of /ɪəɹ̣, ɪə̣ɹ/, which presents a complication due to the existence of two fundamental types of English accents, British and American. As elsewhere, the problem is resolved diaphonemically. American English is 'rhotic', or in other words *r* is pronounced in all cases, not just when transcribed /ɹ/ (*ie* in front of vowels), but also as the diaphoneme /ɹ̣/ (*ie* in word-final position, or before a consonant): *hear*, *hears*, *hearing* /ˈhɪəɹ̣, ˈhɪəɹ̣z, ˈhɪə̣ɹɪŋ/ [ˈhɪˑɹ̈, ˈhɪˑɹ̈z̥, ˈhɩɹɩŋ]. British English, on the other hand, has not been rhotic for about the last three centuries, and has therefore become 'non-rhotic': [ˈhɪˑɐ, ˈhɪˑəz̥, ˈhɩəɻɩŋ]. From the transcriptions, it can be seen that British English has diphthongs in these three cases as well (and in the case of /ɛəɹ̣, ɛə̣ɹ; ʊəɹ̣, ʊə̣ɹ/, too).

8.28. It is certainly true that in English, there are also other vowel sequences, which form triphthongs. However, in these cases we are always dealing with combinations of elements which have already been seen elsewhere. For example, British English has: *higher* /ˈhaɛəɹ̣/ [ˈhaɘɐ], *tower* /ˈtaɔəɹ̣/ [ˈʈhaɵɐ], *slower* /ˈslɔʊəɹ̣/ [ˈslɜɷɐ], and in both accents we have: *Hawaii* /həˈwaɛi, -ˈwɑːi, -ˈwɑːɪi/ [hɯˈwaɘi, -ˈwɑˑi, -ˈwɑˑɪi], *Haweis* /ˈhɔːɪs, ˈhɔɛs/ [ˈhɔˑɩs[a], ˈhσˑɩs[b], ˈhσɘs], *Louis* /ˈlʊuɪs, ˈlʊui/ [ˈlʊuəs[a], ˈlμuɩs[b], ˈlʊui[a], ˈlμui[b]]; also, in the word *idea*, the neutral British pronunciation is generally: /aɛˈdɪə/ [aɘˈɖɪˑɐ], while the American is: /aɛˈdɪiə/ [aɘˈɖɪiʌ].

German has three *monophonemic* diphthongs: /ae, ao, ɔʏ/ [ae, ao, ɔʏ], which have, inevitably, many different realizations in different accents. These can be seen in Ⴖ 5 of *HPr*, and also in the dialect phonosyntheses of Ⴖ 17, in *NPT*/*HPh*: Alsatian, (Munich) Bavarian, Luxembourger, Mocheno German (Italy), (Alto Adige) Tyrolese (Italy), Viennese, (Zurich) Swiss German. In these other dialects, other diphthongs can be found, of a centralizing type, which can be generically described as /iə, yə, uə/. Phonetically, there is much more variety than the phonemic or graphemic notation of many descriptions would encourage one to think.

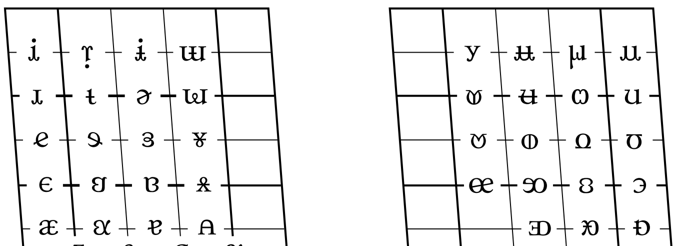
For the sake of simplicity, we now consider the typical realizations of the three canonical phonemes in just the broad regional accents of Vienna and Zurich. Given the examples *Eis*, *Haus*, *neun* /ˈaes, ˈhaos, ˈnɔʏn/, in neutral German, we have: [ˈʔaes, ˈhaos, ˈnɔʏn], while in the accent of Vienna: [ˈɛɘs/ˈæɜs, ˈhɵɵs/ˈhɒɵs, ˈnɔə̯n/ˈnʌʏn/ˈnɐɞn] (also [ɜɵø, œø])], and in that of Zurich: [ˈʌiz̥, ˈhɐµz̥, ˈnɞin/ˈnɘin]. If we were, for the sake of hypothesis, to consider the three diphthongs as bi-phonemic, that is, formed from combinations of five independent elements, such as /e, a, ɔ, o, ʏ/, the diaphonemic aspect of the transcription would be lost, thereby rendering this sort of transcription of no utility.

8.29. As happens with contoids, also for vocoids some special *halfway* symbols may be necessary, if we want to avoid having to decide almost on the toss of a coin which symbol to use, as when within *offIPA*, two different transcribers might chose either [e] or [ɛ], [o] or [ɔ], [a] or [ɑ], for actual [ᴇ, ɵ, a]. These further *canIPA* symbols can be useful, when we want to highlight articulatory nuances between different accents of one language, as well. For Spanish and Italian, for instance, it could be expedient to use symbols which are astride two (or even four, *cf fig* 8.15) others: [e/ᴇ] ⟦ɇ⟧, [ᴇ/ɛ] ⟦ϵ⟧; [o/ɵ] ⟦ʊ̄⟧, [ɵ/ɔ] ⟦э⟧; [ᴀ/a] ⟦a̶⟧, [a/ɑ] ⟦ɑ̶⟧; even astride: [i/ɪ] ⟦ɪ̇⟧, [ɪ/e] ⟦ɪ⟧, [u/ʊ] ⟦ɰ⟧, [ʊ/o] ⟦u⟧. This last series might be useful for variants of German as well, together with [y/ʏ] ⟦ʏ⟧ and [ʏ/ø] ⟦ʊ̈⟧. Besides, the following could come in handy as well [ɛ/æ] ⟦æ⟧, [æ/ᴀ] ⟦ᴁ⟧, [ɑ/ɑ] ⟦ɑ̶⟧; and [ɔ/ɒ] ⟦ɒ̶⟧.

For the sake of completeness, *fig* 8.12 shows the 42 halfway symbols for vocoids which could actually be useful. As a matter of fact, it concerns cases where any decision to use either symbol between more normal ones could conceal some important realities. These symbols can resolve this dilemma over the best way to render nuances accurately, avoiding troublesome and ugly diacritics (and, indeed, ambiguous ones), just as we decided to do also for certain contoids, which are typical of particular languages or variants).

The first vocogram shows the unrounded 'halfway' vocoids; the second, the rounded ones. But it is recommended to use (some of) them in cases of real necessi-

fig 8.12. Possible 'special' symbols for intermediate *canIPA* vocoids.



ty and, above all, if one actually knows how to do it. Otherwise, 'normal' *canIPA* symbols –or even *offIPA*– should be sufficient. In certain books and websites one can even find official quadrilaterals very much alike for different languages (with markers absurdly placed exactly on *cardinal* points).

canIPA vocoids & correspondent *offIPA* symbols

8.30. We now present systematically our 60 vocoids (omitting the 'special' ones) and their correspondents among the 28 official ones; this task will obviously require adding a fair amount of diacritics to the official ones, if they are not to remain generic and vague. We give the eight potential vocoids as well, so that the differences can be better understood – in fact, as we have already mentioned, in our system the more normal and natural values are given to the traditional symbols. We include 18 with intermediate lip position as well. We show by (=) perfect coincidence in the use of symbols, by (≡) an approximate coincidence, and by (≠) a conflict between the two systems.

[i] '[i]' (=)
[ɪ] '[ɪ]' (≡)
[e] '[e]' (=)
[ᴇ] '[e̞] or [ɛ̝]'
[ɛ] '[ɛ]' (=)
[æ] '[a]' (≠)

[ɪ̣] '[i̠], [ï] or [ɨ̟]'
[ɩ] '[ɪ̠] or [ï]'
[ɘ] '[e̠], [ë] or [ɘ̟]'
[ⱻ] '[ɛ̽] or [e̽]'
[ɑ] '[a̽] or [ɛ̈], [ɛ̠]'
[ᴀ] '[ä] or [a̠]'

[ɨ] '[ɨ]' (=)
[ᵻ] '[ɨ̞] or [ə̝]'
[ə] '[ə] or [ə̝]'
[ɜ] '[ɜ]' (=)
[ɐ] '[ɐ]' (=)
[a] '[ä̠] or [ɐ̞]'

[ɯ] '[ɯ̈], [ɯ̟]'
[ɯ] '[ɯ̽], [ɯ̟̞], [ɯ̞̈] or [ɤ̝̈]'
[ɤ] '[ɤ̟] or [ɤ̈]'
[ɤ] '[ʌ̽], [ʌ̝̈] or [ɤ̽], [ɤ̞̈]'
[ʌ] '[ʌ̟], [ʌ̈]'
[ɑ] '[ɑ̟], [ɑ̈]'

[ш] '[ɯ]' (≠)
[ɰ] '[ɯ̞] or [ɤ̞]'
[x] '[ɤ]' (≠)

[x] '[ɤ̞] or [ʌ̝]'
[ʌ] '[ʌ]' (≠)
[α] '[ɑ]' (≠)

[ʏ] '[y]' (≠)
[ɥ] '[ʏ]' (≠)
[ø] '[ø]' (≠)
[ɵ] '[ø̞] or [œ̝]'
[ꭢ] '[œ]' (≠)
[ɶ] '[ɶ]' (≠)

[y] '[ÿ], [ȳ]'
[ʏ] '[ʏ̈], [ʏ̠]'
[ø] '[ø̈], [ø̠]'
[ɵ] '[œ̽], [œ̝̈] or [ø̽], [ø̞̈]'
[œ] '[œ̈], [œ̠]'
[ɶ] '[ɶ̈], [ɶ̠]'

[ʉ] '[ʉ]' (=)
[ʊ] '[ʉ̞] or [ɵ̝]'
[ɵ] '[ɵ]' (=)
[ɞ] '[ɞ]' (=)
[ꝏ] '[ɞ̞]' (≠)
[ʚ] '[ɶ̠̈]' (≠)

[µ] '[ü], [u̟]'
[ω] '[ʊ̈], [ʊ̟]'
[ʊ] '[ö], [o̟]'
[ɔ] '[ɔ̽], [ɔ̝̟] or [ö̽], [o̞̟]'
[ɘ] '[ɔ̈], [ɔ̟]'
[ɒ] '[ɒ̈], [ɒ̟]'

[u] '[u]' (=)
[ʊ] '[ʊ]' (≡)
[o] '[o]' (=)
[σ] '[ɔ̝] or [o̞]'
[ɔ] '[ɔ]' (=)
[ɒ] '[ɒ]' (=)

[i̯] '[i̹] or [y̜]'
[ɨ̯] '[ɨ̹] or [ʉ̜]'
[ɯ̯] '[ɯ̹̟] or [u̜̟]'

[ɪ̯] '[ɪ̹] or [ʏ̜]'
[ɩ̯] '[ɪ̹̄] or [ʏ̜̄]'
[ɯ̯] '[ɯ̹̄] or [ʊ̜̟]'

[e̯] '[e̹] or [ø̜]'
[ɘ̯] '[ē̹], [ë̹] or [ɘ̹̟]'
[ɤ̯] '[ɤ̹̟] or [o̜̟]'

[ɘ̯] '[ē̹] or [ɛ̹̟]'
[ɜ̯] '[ɜ̹] or [ɞ̜]'
[ɤ̯] '[ʌ̹̽], [ʌ̹̝̈] or [ɔ̜̽], [ɔ̜̝̈]'…

[ɛ̯] '[ɛ̹] or [œ̜]'
[ɑ̯] '[a̹̽] or [œ̜̄]'
[ʌ̯] '[ʌ̹̟], [ʌ̹̈] or [ɔ̜̟], [ɔ̜̈]'

[æ̯] '[a̹̟] or [ɶ̜̟]'
[a̯] '[ä̹̠] or [ɐ̹̄] or [ɶ̜̠̈]'
[ɑ̯] '[ɑ̹̟], [ɑ̹̈] or [ɒ̜̟], [ɒ̜̈]'.

8.31. Going back to *canIPA* vocoids, let us notice that with [e̙, o̘] we indicate backing or fronting of the dorsum (whereas *offIPA* uses [e̠, o̟] for this purpose, but [e̙, o̘] for the so-called 'retracted/advanced tongue root'. Instead, in our system [_] indicates spread or neutral lip-position, as in the general symbol [V̠]. (Let us also observe that paraphonically ⟨V̠⟩ indicates an added smile while speaking; whereas ⟨V̮⟩ shows pouting, *cf fig* 8.14.)

We have seen (*cf fig* 8.9-10) that, when using actual –not generic– symbols, it can be useful to be able to indicate an intermediate lip-position between neutral (and spread as well) vocoids and rounded ones, as in [ɘ, ɘ̮, ø] or [ʌ, ʌ̮, ɔ], *cf fig* 8.13. However, it could be important to be able to also distinguish further degrees such as [ɘ, ɘ̮, ø̠, ø, ø̮] or [ʌ, ʌ̮, ɔ̠, ɔ, ɔ̮]. In fact, sometimes it is useful to show *slightly* delabialized phones, such as the third elements in the series just given, [ø̠, ɔ̠], or else *slightly* labialized phones, such as the second ones, [ɘ̮, ʌ̮]. When these notations are useful and used, we have to explicitly indicate that it is not the plain intermediate position between unrounded and rounded vocoids, *ie* half-rounded ones (*fig* 8.13), as can be seen from *fig* 8.14. In addition, if necessary, the last elements of the series given above are used to indicate that (already) rounded vocoids are over-rounded, [ø̮, ɔ̮] (*fig* 8.14).

Also for central approximants, above all, it could be useful to distinguish degrees of labialization, as for instance in: [ɰɻ, ɰ̮ɻ, w̠, w, w̮].

fig 8.13. Scale of *three* labial positions.

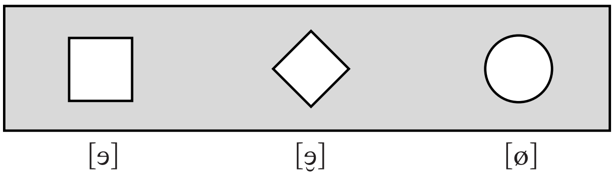
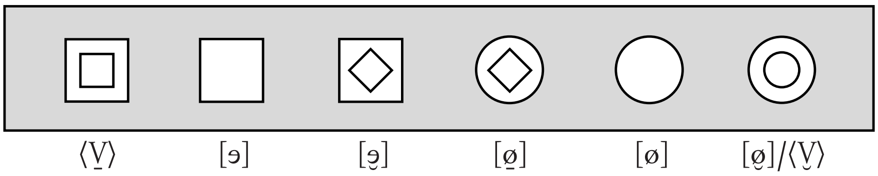


fig 8.14. Scale of *six* labial positions (the first is paraphonic as the last one can be).

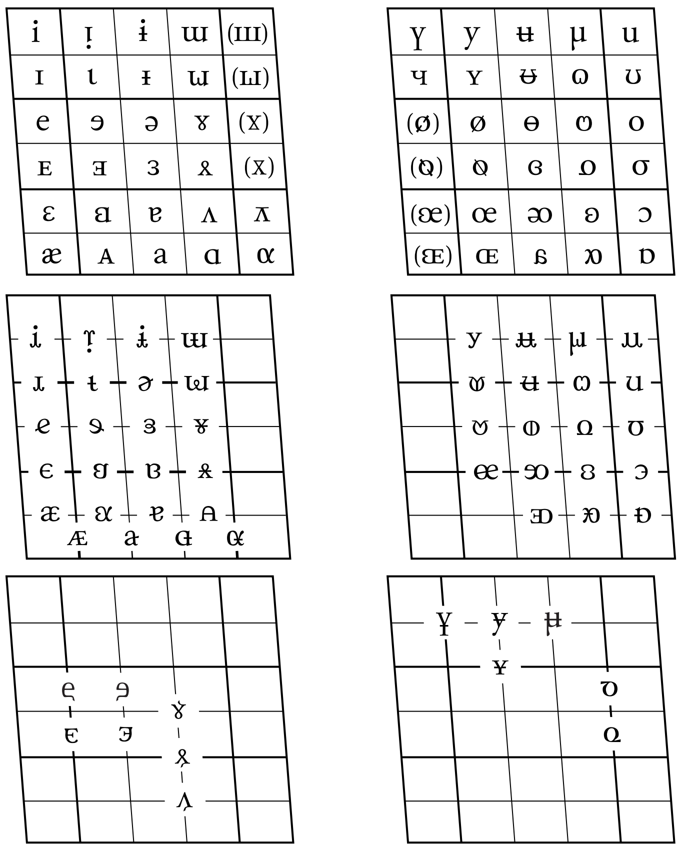


Appendix

Intermediate vocoids

8.32. Considering *fig* 8.12, let us expand a bit the number of possibilities for 'special' –or halfway– symbols for intermediate *canIPA* phones. For easier comparisons, we show normal *canIPA* vocoids, followed by those of *fig* 8.12 (mostly for vertical insertions), adding a further possible set of special intermediate vocoids (for crosswise insertions, between two or four other symbols). Of course, these are not really necessary. But, indeed, they could be useful to distinguish between accents of a same language, when other 'special' symbols are already used to show timbre nuances, which might be important not to ignore.

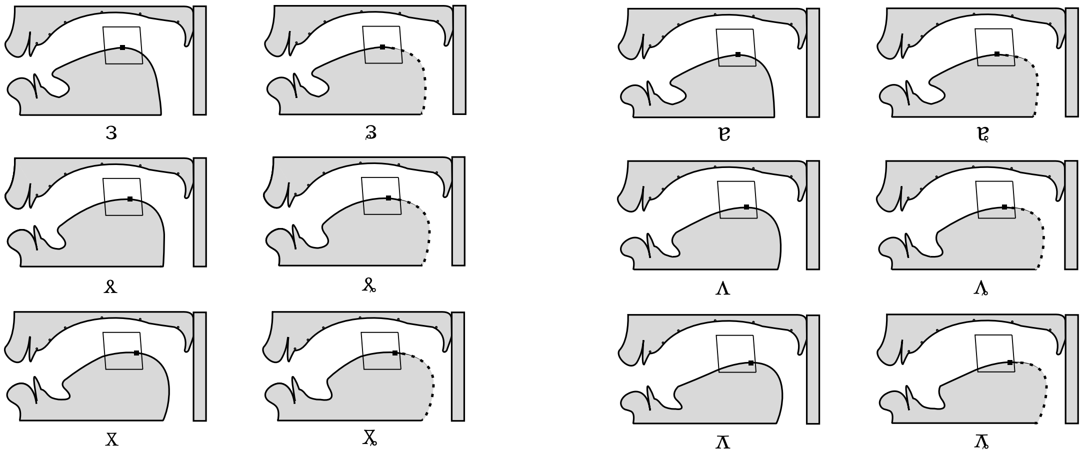
fig 8.15. Further possible 'special' symbols for crosswise intermediate *canIPA* vocoids.



Uvulo-pharing(e)alized vocoids

8.33. To accurately describe certain pronunciations of German, for instance, we need to identify at least five such vocoids, that we show side by side with their plain correspondent vocoids.

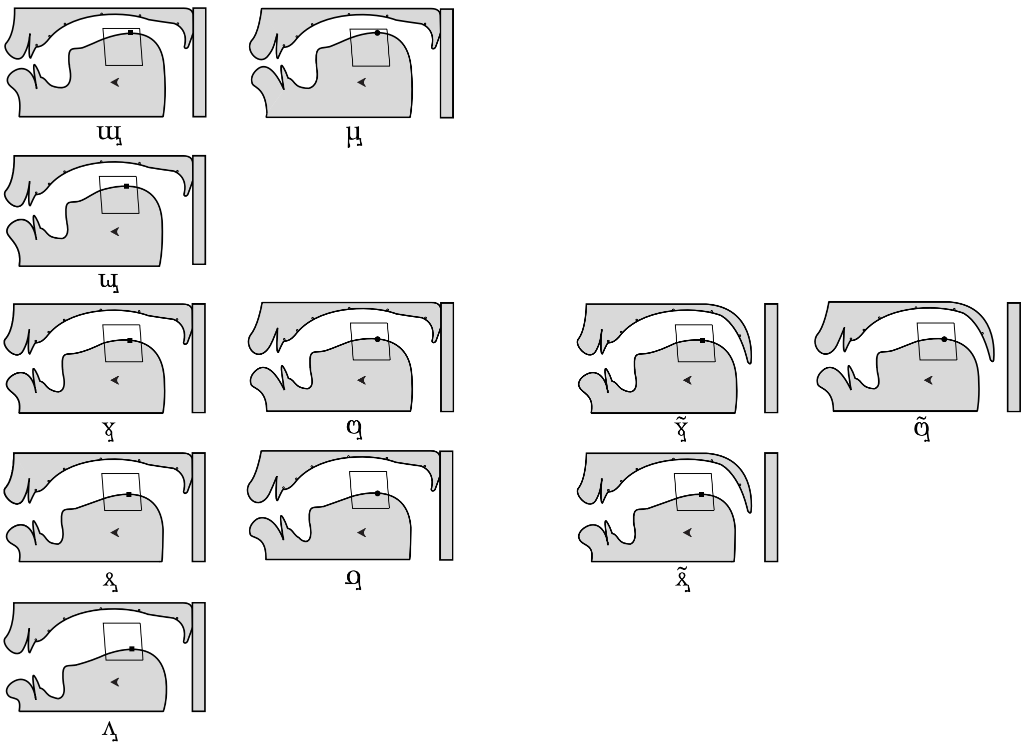
fig 8.16. Some uvulo-pharyng(e)alized *canIPA* vocoids.



Lateralized (or latero-contracted) vocoids

8.34. Equally, to accurately describe the neutral pronunciation of Mandarin Chinese, we need to identify at least eleven such vocoids, that we show side by side with their plain correspondent vocoids.

fig 8.17. Some lateralized (or latero-contracted) *canIPA* vocoids.

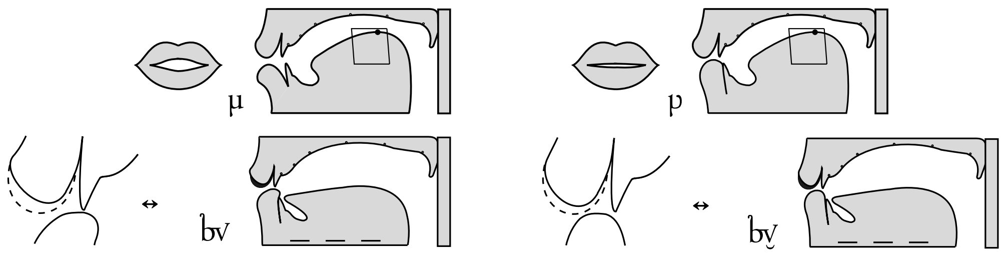


Labiodentalized vocoids

8.35. To describe the mediatic accent of the Netherlands, we need at least a labiodentalized vocoid taxophone, [p], that we compare with its plain rounded counterpart, as a general vocoid, [μ] (though Netherlandic has [u] for /u/). It can occur for /VuV/, mostly /Vuə/, which often becomes [VʋV, Vʋə], and thus [VpV, Vpə], as in *duwen*. (By the way, let us notice that /ʋ/, in International Netherlandic, is rather /β/, and that it is no good idea at all to show it as /w/.)

In the same mediatic accent, before *V* (not necessarily between *V*), /ʋ/ can typically be realized as a voiced labiodental *semi*stop-*semi*(con)strictive by detension (with possible bilabialization, too, that we add in fig 8.18, although it would be more logical, perhaps, to show and treat it in Ch 10): [ɓv, ɓv̯], as in *wie*.

fig 8.18. A labiodentalized *canIPA* vocoid (and two contoidal taxophones).

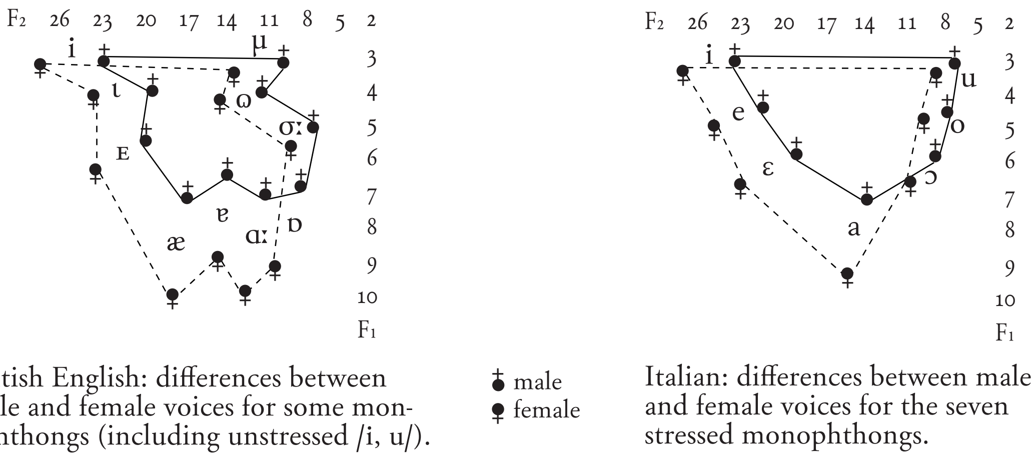


Differences in vocoids for male and female voices

8.36. The human ear can normally distinguish between male and female (and, indeed, infant) classes of voices, in an easy and automatic way, by spontaneously compensating and calibrating all the actual differences that we all can perceive.

However, acoustically this cannot be done in such a natural and immediate way, as fig 8.19 clearly shows, although these diagrams result from an average of several voices. Instead, each single voice would inevitably show many surprising and puzzling peculiarities.

fig 8.19. The acoustic way of 'showing' phonic things.



British English: differences between male and female voices for some monophthongs (including unstressed /i, u/).

Italian: differences between male and female voices for the seven stressed monophthongs.

Palatograms of *canIPA* vocoids

8.37. Let us observe very carefully the palatograms of our vocoids, also by comparing them with those of contoids (shown in *fig* 10.9.12-13, as well).

fig 8.20. Vocograms with *canIPA* vocoids.

	front (0)	front-central (1)	central (2)	back-central (3)	back (4)
high (A)	i	ị	ɨ	ɯ	(ш)
lower-high (B)	ɪ	ɩ	ᵻ	ɰ	(ɯ)
higher-mid (C)	e	ɘ	ə	ɤ	(x)
lower-mid (D)	ᴇ	ᴲ	ɜ	ɤ̞	(x)
higher-low (E)	ɛ	ɐ	ɐ	ʌ	ʌ
low (F)	æ	ᴀ	a	ɑ	α

unrounded

	front rounded (5)	front-central round. (6)	central rounded (7)	back-central round. (8)	back rounded (9)
high (A)	γ	y	ʉ	µ	u
lower-high (B)	ч	ʏ	ᵿ	ɷ	ʊ
higher-mid (C)	(ø)	ø	ɵ	ɷ	o
lower-mid (D)	(ɸ)	ɸ	ɞ	ɒ	σ
higher-low (E)	(ɶ)	œ	ɞ	ɘ	ɔ
low (F)	(ɶ)	ɶ	ɞ	ɒ	ɒ

rounded

high (A), lower-high (B): CLOSE; higher-mid (C), lower-mid (D): MID; higher-low (E), low (F): OPEN

fig 8.21. Palatograms of *canIPA* vocoids.