

Teaching vowels physically

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ABSTRACT

This paper explores issues surrounding teaching vowels physically. First the inherent difficulty of describing vowels compared to consonants is examined. Next the traditional descriptions of vowel formation by early phoneticians are presented along with other early phonetic constructs, such as the Cardinal Vowels and the vowel quadrilateral. The author argues against a blanket acceptance of these ideas. Despite being well-known among the speech teaching community, many speech science researchers have long since discredited many of these established concepts. The relevant findings are evaluated and it is maintained that there can be no exact articulator positions for vowel sounds. Nevertheless, the author argues that speech teachers should teach physical positions for vowels, as students learn more effectively when a multi-modal (tactile, visual and auditory) approach is offered. To this end, the vowel quadrilateral is offered as a tool to not only show approximate tongue positions, but also for indicating auditory qualities. As long as students remain aware that physical descriptions of vowels are imperfect, they will benefit from such instruction. The concluding discussion examines how the author likes to coach vowels in his own teaching practice and provides guidance on how to teach vowels physically without misleading students.

KEYWORDS

Articulatory phonetics; Cardinal Vowels; vowel quadrilateral; vowel teaching methods; EFL; accents for actors

The challenge of describing vowels

The International Phonetic Association categorises consonants in its consonant table with the following labels: *voicing*, *place*, and *manner of articulation*.¹ After explanation of these terms, it should be reasonably straightforward for a speaker to check whether their larynx is vibrating, to feel where the place of articulation is, and to perceive how the air is obstructed while passing through the vocal tract. For example, when producing a /v/ sound (like in the word *ever*), the larynx vibrates, the lower lip articulates against the upper incisors, and the airflow has characteristically fricative turbulence.

Vowels are less easy to categorise. In English, the larynx vibrates when producing vowels and the airflow is not obstructed. This means all vowels are *voiced*² and have the same *manner*. Given that there is no airflow obstruction, it is challenging for a speaker (especially, one who is not phonetically trained) to feel the positions of the articulators (the *place*). Looking

in a mirror can determine lip position, but if a speaker wants to look inside the mouth then the jaw will need to open to such an extent that the articulators will be moving in different ways to compensate for jaw aperture.

Traditional descriptions of vowels

In the past, phoneticians had to rely on mirrors and proprioception to describe vowel sounds. Vowels were described in terms of lip position and whether the tongue was high or low and front or back. Incidentally, these ideas were further developed by Alexander Melville Bell (1819–1905), whose concepts can be seen in the film *My Fair Lady*.

However, only providing labels describing the height and frontness of the tongue can never be precise. Stating that a certain vowel is made with the tongue high and back with spread lips will inevitably be interpreted differently by different people. (What part of the tongue is raised? How high? How back?). In comparison, descriptions of consonants with the labels *voicing*, *place* and *manner* can be much more precise (e.g. a voiced retroflex fricative or a voiceless bilabial nasal).

Cardinal vowels and the vowel quadrilateral

In an attempt to solve the problem of imprecise vowel description, British phonetician Daniel Jones (1881–1967) created his system of Cardinal Vowels (abbreviated to CVs) in 1917. These could be used as reference points to describe the position of any vowel sound.

There are 18 Cardinal Vowels. Cardinal Vowel 1 [i] is made with the tongue as high and forward in the mouth as possible (without creating friction and thus turning into a consonant). CV 8 [u] is made with the tongue as high and back in the mouth as possible. CV 5 [a] is made with the tongue as low and back in the mouth as possible. CV 4 [ɑ] lies in the remaining corner. *The Handbook of the International Phonetic Association* (1999) presents the following diagram on page 11:

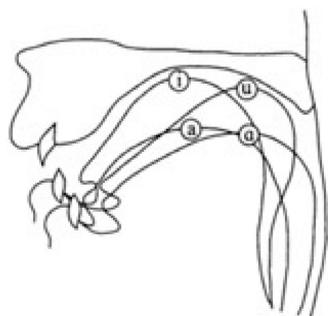


image © Cambridge University Press

It is described as “a mid-sagittal section of the vocal tract with four superimposed outlines of the tongue’s shape” (10).

The symbols [i, u, a, ʌ] are placed in the positions judged to be the highest point of the tongue when articulating these vowels. The Handbook states that:

... joining the circles representing the highest point of the tongue in these four extreme vowels gives the boundary of the space within which vowels can be produced. For the purposes of vowel description this space can be stylized as the quadrilateral shown... (12)

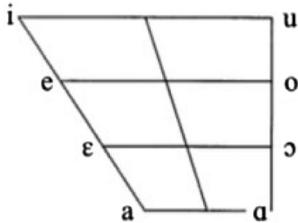


image © Cambridge University Press

This vowel quadrilateral³ is designed to make it easier to understand where vowels are made in the mouth. Aside from the four corner vowels, a further four extra vowel symbols [e, ɛ, o, ɔ] have been added onto the diagram. These are placed at “acoustically equidistant” intervals (this term will be explored later).

Vowels in language

The image below is a vowel quadrilateral illustrating the vowels in Standard Italian.

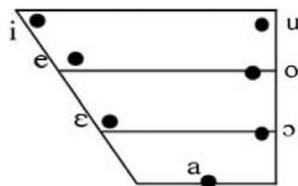


image © Journal of the International Phonetic Association (Rogers and d’Arcangeli 2005).

Compared to the vowel quadrilateral displaying the Cardinal Vowels, the Italian vowels appear to be articulated in different positions. Cardinal Vowel 4 [a] in Daniel Jones’s system is made with the tongue as low and front as possible, but in Italian the [a] vowel sound is made more centrally.

In fact, vowels can be articulated in any part of the vowel quadrilateral. Rather than have different symbols for every point on the diagram, dots can be placed where a vowel is made and the nearest Cardinal Vowel symbol is used to mark it. Ashby and Maidment (2005, 76) explain that the dot means “... something like: the vowel x sounds as if it is produced with the highest part of the tongue in this position”.

Tongue positions discredited

Thus far it appears that the vowel quadrilateral depicts exact tongue positions, but this is not the case. Despite providing a diagram with tongue positions for the Cardinal Vowels, the *Handbook of the International Phonetic Association* states that vowels:

... are classified in terms of an abstract “vowel space”, which is represented by the four-sided figure known as the “Vowel Quadrilateral” ... This space bears a relation, though not an exact one, to the position of the tongue in vowel production.... (1999, 10)

... the vowel quadrilateral must be regarded as an abstraction and not a direct mapping of tongue position. (12)

This is understandably confusing given that the *Handbook* has provided illustrations of tongue positions for vowels.

Acoustically equidistant?

Earlier the term “acoustically equidistant” was introduced to describe the positions of the intermediate vowels [e, ε, o, ɔ]. In response to this, the phonetician Peter Ladefoged states the following:

[Daniel] Jones never defined what he meant by saying that the cardinal vowels were acoustically equidistant. He thought that the tongue made equal movements between each of them, even after the publication of x-ray views of the 8 primary cardinal vowels produced by his colleague Stephen Jones showed that this was not the case ... Daniel Jones himself published photographs of only four of his own cardinal vowels, although, as he told me in 1955, he had photographs of all 8 vowels. When I asked him why he had not published the other four photographs, he smiled and said “People would have found them too confusing”. (*An academic life*, 1)

In fact, the American speech scientist George Oscar Russell published an X-ray study of tongue positions for vowels in 1928. A reviewer of the study in 1929 stated that “... the evidence demolishes the theory that vowel quality is solely or even chiefly dependent upon the position of the surface of the tongue”. (Sturtevant 1929, 34).

New research on vowels

Increasingly phoneticians have had access to technology, such as X-rays, ultrasound, and MRI to confirm that vowels do not have set articulator positions. In fact, it has been determined that the same vowel can be realised using different articulator configurations. Gick, Derrick, and Wilson (2003, 155) explain that “... X-ray film studies have shown that some speakers use their jaw for changing vowel height, while others barely move their jaw and instead appear to change the shape of their tongue”. Ladefoged and Disner point out that different speakers will use different muscle configurations to create the same sound:

Some people vary the height of the tongue in *heed*, *hid*, *head*, *had* mainly by using the genio-glossus muscle, others make more use of the mylohyoid muscle, and yet others control tongue position more by raising and lowering the jaw. You can produce the required tongue shape in several different ways. (2012, 128)

More recently, Jonathan Havenhill (2015, 1) conducted an ultrasound study on American English vowel sounds and discovered that “While some speakers distinguish /ɔ/ from /ɑ/ with a combination of tongue position and lip rounding, others do so using either tongue position or lip rounding alone”. Ashby and Maidment (2005, 77) rightly state that “... the configuration of the entire vocal tract needs to be taken into account”⁴

Considering this evidence, it is clear that a particular vowel sound does not have an exact tongue, lip and jaw position. However, I do still believe that vowels should be taught physically and that the vowel quadrilateral should not be dispensed with as a teaching

tool. *Gimson's Pronunciation of English* (Cruttenden 2014, 39) agrees stating that "... it is convenient to have available a rough scheme of articulatory classification". As does the phonetician J. C. Catford:

The traditional way of classifying vowels works well in practice, and, indeed is the only basis for the successful acquisition of practical skill in producing, identifying, and classifying vowels... [it is] helpful to use a hand mirror ... so that one can correlate the visible movements and positions of the tongue and lips, with the proprioceptive sensations, and also with the auditory sensations when they are whispered or voiced. (2001, 119, 120)

My own teaching practice

In the following section, I will discuss my own techniques and teaching methodology. As well as sharing my experiences of teaching vowel sounds, I shall explain what has worked most effectively for my students.

Moving the tongue

When introducing vowels to non-native English speakers and native/non-native actors, I start by exploring the peripheral vowels [i, u, a, ʌ]. The student repeats the vowels and feels the corresponding tongue movements. Subsequently, I ask them to observe those tongue movements in a mirror to verify what they feel. Usually the tongue moves high and front for CV 1 [i] and high and back for CV 8 [u]. Some students initially believe that the tongue is not involved in the process of creating vowel sounds because they have little proprioception in the mouth. This exercise proves that tongue movement is intrinsic to producing vowels.

Next, I invite the student to create the same vowel (e.g. [a]) with the jaw more open and then more closed. Students are usually surprised to discover that they are able to do this. I ask the student to experiment with creating the same vowel with diverse articulator positions (e.g. [o] with different lip positions). In this way, the student understands that vowels do not have exact tongue, jaw and lip positions.

Afterwards, I introduce the vowel quadrilateral superimposed onto a mid-sagittal section of the vocal tract. IPA symbols of the peripheral vowels are mapped onto it. I ask the student to slowly move the tongue between peripheral vowels (e.g. from [a] to [i]). By doing this, the student can feel the tongue movement more easily and visualise it by looking at the quadrilateral. Of course, vowels lie on a continuum and while sliding between two vowels other vowels will be perceived. One of my Finnish students found this exercise of sliding between [i] and [a] particularly useful when approaching the /ɪ/ phoneme. She suddenly understood that /ɪ/ needed to be made in a lower tongue position compared to /i:/. By placing the /ɪ/ symbol underneath the /i:/ symbol on the quadrilateral, she was also able to visualise where she needed to aim. After a week of focusing on a lower tongue position while practising, she managed to consistently produce /ɪ/. She commented that the instruction of a lower tongue position was extremely useful. Of course, she was not focusing on an exact position, but rather a lower position compared to /i:/. Such exercises demonstrate to the student that the vowel quadrilateral can be very helpful for indicating approximate tongue position.

Vowels on the quadrilateral are commonly indicated by a dot with the IPA symbol next to it. Most works on phonetics describe the tongue arching towards these dots. However,

Speaking with Skill by Dudley Knight (2012) describes the tongue arching upwards for high vowels and cupping downwards for low vowels. Knight states the following:

The total space within the vowel quadrilateral represents – in an imprecise, schematic way – the action of arching or cupping of the front, middle or back of the body (or dorsum) of the tongue. It does not involve the tip or the blade.⁵ (177)

I have found that some students immediately understand the concepts of “arching” and “cupping” and thus are able to create a particular vowel otherwise elusive to them. For example, I coached a Czech student who was unable to accurately target the /ɑ:/ vowel. After experimenting with cupping in the back of the mouth, he was soon able to produce the vowel. For some, like my Czech student, these terms make immediate sense and help create a new sound. Other students find they are unable to cup their tongue, or that the concepts do not make sense. Discussions of exactly how the tongue moves when arching and cupping can be problematic. If one part of the tongue is strongly cupped, then another part of the tongue may raise into an arch. This is why Knight describes these movements within an “imprecise, schematic” representation. I tend to use the idea of “cupping” as one tool among others. As all good teachers know, different students will respond to different techniques. If “cupping” works for one student, it does not mean the instruction should be insisted upon for another.

I certainly recommend teaching approximate tongue positions for vowels because I have seen good results from this method. Indicating vowels on the quadrilateral by means of a dot and symbol works well. However, as well as indicating where a new vowel is, it is equally important to show where other vowels are so that the student has a frame of reference. Moreover, it is unproductive to state that a vowel is made with the tongue high and central if the student has not yet understood the difference between high/low or front/central/back in their own mouth. This is why exercises which explore the vowel space are so important.

The jaw

A further benefit of using the vowel quadrilateral is that students concentrate on the tongue rather than the jaw. If a student is taught that a vowel has a low jaw position, then they will tend to overextend the jaw whenever they pronounce a word containing this vowel. This can be painful (especially, if the student has tight jaw muscles) and potentially lead to jaw problems such as TMD (temporomandibular disorder). A Russian student I taught found it particularly challenging to create the /a/ vowel sound in SSBE (Standard Southern British English). Being an enthusiastic student, she had researched this in pronunciation textbooks and on the internet. Many of these sources describe a low jaw position for this vowel (I have seen several YouTube videos, in which the presenter exaggerates the open jaw movement in their demonstrations). Given that this student had particularly tight jaw muscles, it was understandably painful when she attempted to mimic what she had seen. As an exercise, I instructed her to keep her teeth together (i.e. with a high jaw position) and create various vowels, which she was able to do. This taught her that she could create vowels without involving the jaw. Afterwards, she managed to relax and forget about the jaw, while learning the /a/ phoneme. At the same time, I gave her additional exercises to release jaw tension.

Aside from specific jaw positions for vowels, another popular misconception is that it is important to open the jaw wide when speaking in a foreign language. One of my French students did this to the extent that it looked like a speech pathology issue. He complained

that whenever he practised speaking English, his jaw muscles really ached. I invited him to talk about his day in his native language and pay attention to how much he was using his speech muscles. Afterwards I asked him to rate the amount of muscular effort he was using on a scale from 1 (=least effort) to 10 (=most effort). He judged it to be about 4. I explained that in English he was speaking at level 10, which was unnecessary not only for communication, but also for creating sounds that did not exist in French. This scale immediately gave him perspective and allowed him to reduce muscular effort. When we began to learn specific vowel sounds, he would revert to his previous mindset of overextending the jaw because it was a foreign sound. As well as reminding him of the effort scale, I asked him to practise vowels, while looking in a mirror. This gave him the visual feedback he needed to realise when he was overextending the jaw. Once he was aware that he was exerting too much effort, he relaxed, he sounded more natural and his jaw muscles were saved from being damaged.

I recommend that students should be taught approximate tongue positions for vowels rather than exact jaw positions. If it is necessary to adjust a student's jaw position, then the instruction should be to relax the jaw rather than to open the jaw. This will avoid causing unnecessary tension or jaw damage.

The lips

As mentioned earlier (Havenhill 2015, 1), some speakers may make a vowel with the tongue more back and the lips relaxed, others with the tongue more forward and the lips more rounded. If a student is not responding to instructions for tongue position, then I recommend adjusting the lip position to compensate.

A Polish student of mine would use her native /u:/ vowel sound, while speaking English. It was particularly back (similar to CV 8 [u]) and realised with strongly rounded and protruded lips. However, SSBE (Standard Southern British English) has a much more central vowel [ʊ] for this phoneme. My student found it particularly challenging to adjust tongue position so I asked her to keep her lips relaxed, while making the vowel. She found it much easier to control the lips and so managed to front the vowel sound in this way.

Moreover, it is helpful to look at the neutral lip position of the target accent.⁶ From my observations, SSBE speakers speak with relatively relaxed lips and use little lip movement for most vowels in casual, spontaneous speech.⁷ One my Spanish students had an extremely spread lip position whenever she spoke (to the extent that people she came across in the U.K. assumed she was constantly happy and smiling). Of course, this affected most vowel sounds (including, the /i:/ phoneme which was too high and front for a native-sounding SSBE accent). I did some exercises with her to explore lip movement, such as bilabial trills and switching between pursing and spreading the lips. These helped her gain more proprioception of how her lips were moving. I asked her to speak about her day with the lips in a narrower position. While talking, she looked in a mirror for visual feedback. Instantly she began to produce her vowels in a more SSBE fashion.

I recommend using lip position to help when a student is slightly away from the target vowel. If the vowel is too back, then the student can slightly spread the lips, if the vowel is too front, then the student can slightly round the lips. It is necessary to observe speakers of the target accent before teaching lip position. Assuming that an /i:/ phoneme has strongly

spread lips and an /u:/ phoneme has strongly rounded lips, like CVs 1 and 8 is not true for all languages and accents.

Auditory qualities on the vowel quadrilateral

The vowel quadrilateral is also a useful tool for describing the auditory quality of the vowel. Collins and Mees (2013, 67) describe it as “a mapping system which presents what is essentially auditory and acoustic information in a convenient visual form”. Ladefoged and Disner (2012, 131, 132) explain that past phoneticians “thought they were describing the highest point of the tongue, but they were not. They were actually describing formant frequencies”. After explaining the concept of formant frequencies, I will explore its relevance for the speech teacher.

Formant frequencies

Vowels can be thought of as possessing many different overtones simultaneously in addition to the pitch of the voice (the *fundamental frequency*). These overtones are called harmonics. When sound energy moves through the vocal tract these harmonics are filtered according to the shape of the resonating cavities (e.g. pharyngeal, oral, nasal). Some harmonics are amplified and others are dampened. These amplified harmonics are called formant frequencies and give vowels their characteristic quality. (Ladefoged and Johnson 2011, 187–189)

The lowest two formant frequencies (F1 and F2) are most important in distinguishing vowels in Standard Southern British English.⁸ There is a relationship between the formant frequencies and the shape of the vocal tract. For example, when the tongue is high and front (like for [i]), generally F1 is lower and F2 is higher. When the tongue is low and back (like for [ɑ]), generally F1 is higher and F2 is lower (Cruttenden 2014, 21). These are approximate, but helpful, correlations. The vowel quadrilateral can be viewed as roughly mapping these two formants.⁹

Using formant frequencies to teach vowels

It may seem that formants are for speech scientists and phoneticians rather than for speech teachers. However, F2 can be extremely useful in helping a student target a vowel, or distinguish between vowels. In lessons, I invite the student to whisper [i], [ɛ], [a] and describe the difference in sound quality. Most people perceive the first vowel as brightest, the second as darker and the last as darkest. Others will state the opposite, but this is not important to me so long as a difference can be recognised. I find that the perception of brightness tends to correspond with a higher F2 (and a higher and more front tongue position), whereas darkness corresponds to a lower F2 (and a lower and more back tongue position). Using the vowel quadrilateral as an auditory representation, the top left of the chart will sound brightest and the bottom right will sound darkest. This can be useful in distinguishing the /i:/ and /ɪ/ vowels in English, where the latter sounds darker.

As well as describing tongue positions, the terms *high*, *low*, *back*, and *front* are nowadays often used to express these “auditory qualities” that we perceive from different formant frequencies (Ladefoged and Johnson 2011, 89). *High* and *front* would produce a “brighter” quality, whereas *low* and *back* would be a “darker” quality.

It is important to clarify that this idea of brightness and darkness should not be confused with either actual pitch created at vocal fold level (*fundamental frequency*) or with other harmonic-changing elements like the height of the larynx, for example. It is usually not important to dissuade students from using the terms “higher pitch” and “lower pitch” when referring to vowels. However, the speech teacher should be mindful that demonstrating different vowels at different vocal fold pitches can be confusing, especially to students who have a tonal language background.

Conclusion

Whereas it is easier to feel and see the position of the articulators for consonants, vowels are more challenging to describe. In the past, phoneticians believed that it was possible to prescribe exact tongue, lip and jaw positions for vowels and the vowel quadrilateral was created as a tool to illustrate tongue position. However, since the early twentieth century, research has proven beyond doubt that there are no precise articulator positions for vowel sounds. In fact, different speakers will produce vowels using different muscle configurations.

As a speech teacher, it is important to be aware of the traditional descriptions of vowels. Students may arrive to a lesson with knowledge of this picked up from pronunciation textbooks and/or the internet. If they are frustrated after spending hours attempting to move their tongue into a position stipulated on the vowel quadrilateral, then it is counter-productive to allow them to continue. It is vital to emphasise that the quadrilateral shows only approximate positions.

Many of my students are unable to accurately reproduce a vowel sound that does not exist in their native language. For these people, the only consistently successful teaching method I have found is to use a multi-modal approach. This includes teaching vowels physically. By exploring tactile, visual and auditory sensations, the student is able to access a new sound via different routes. First, tactile: it is important for the student to feel what speech muscles are moving and where. Secondly, visual: the student should be able to see in a mirror, or in their mind’s eye, how the muscles are positioned. Thirdly, auditory: the way in which a new vowel sounds different to other vowels should be clear. Of course, as soon as it seems as if the student is taking the physical instructions too literally, I stress their approximate nature.

The vowel quadrilateral is an excellent tool to discover new vowels through the routes of tactile, visual and auditory sensations. Placing dots and symbols on the vowel quadrilateral will indicate roughly where the tongue should aim, allows the speaker to visualise where the tongue should be, and gives an indication as to the brightness or darkness of the sound. One of my Romanian students recently commented that the quadrilateral was incredibly useful for her, even though she understood it was not a precise physical representation. She was able to visualise where a new vowel lay in the vowel space and thus more easily target it.

If the student is a non-native English speaker then I find it useful to additionally display a vowel quadrilateral illustrating the vowels in their native language for comparison. Sometimes this information can be found for free by searching for the relevant language in *The Journal of the International Phonetic Alphabet* (<https://www.cambridge.org/core/journals/journal-of-the-international-phonetic-association>). Otherwise Wikipedia often has vowel quadrilaterals taken from trusted sources (for example, search for “Spanish phonology”). Bear in mind that the student may have a different vowel inventory depending on

their accent (a speaker from the south of Germany may have different vowels to a speaker from the north of Germany).

Despite overwhelming evidence that there are no exact articulator positions, my students manage to target vowels more accurately when I give guidance on where to move the articulators. A few examples of successful vowel acquisition include a Hungarian student being able to distinguish /ɔ:/ and /əʊ/, a Japanese speaker distinguishing /a/, /ʌ/, and /ɑ:/, and a Luganda speaker distinguishing /ɛ/ and /ei/. All of these students were unable to mimic the sounds accurately until I had explained the vowel quadrilateral and used it to coach them.

I strongly advocate that vowels should be taught physically using the vowel quadrilateral as long as the teacher and student are aware of its limitations.

Notes

1. Other labels to categorise consonants exist, such as *fortis* and *lenis* and descriptions of secondary articulations, but these are unnecessary for the present discussion.
2. In reasonably quick and casual speech, unstressed vowels between voiceless consonants may be devoiced. For example, the first vowel sound in “potato” [pə'tetəʊ].
3. The vowel quadrilateral may also be referred to as the *vowel diagram*, *vowel trapezium*, or *vowel chart*.
4. For example, the position of the articulators for r-coloured vowels (like the /ɜ:/ in most American English speakers' pronunciation of “nurse”) with retroflex approximation, tongue bracing and/or pharyngealisation are not displayed by the quadrilateral.
5. Some rhotic speakers will adopt a retroflex tongue position for the /ɜ:/ vowel, like in the word “nurse”. This means that the tip of the tongue will be involved in the production of some vowel sounds.
6. The idea of a neutral lip position is part of *articulatory setting* (Honikman 1964, 73), also known as *voice quality* (Laver 1980, 1), or *vocal tract posture/oral posture* (Knight 2012, 106–109).
7. As well as guidance for lip position, the speech teacher may need to give other physical instructions. For example, describing the position of the velopharyngeal port, or the amount of tension in the pharynx.
8. The third formant (F3), which characterises rhoticised vowels such as [ɜ:], is useful for distinguishing vowels in rhotic varieties of English.
9. If you imagine an x-axis and a y-axis superimposed on the vowel quadrilateral, the x-axis would show F2 and the y-axis would show F1 inversely (i.e. lower F1 at the top, higher F1 at the bottom).

Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor



Luke Nicholson is an accent coach who set up his business Improve Your Accent in 2012 to help non-native English speakers communicate more clearly and confidently. Recently, his profile has been raised after winning U.K. Freelancer of the Year 2017. He has taught hundreds of clients (actors and non-actors) from over 70 different countries across the world. His website (www.ImproveYourAccent.co.uk) features free and unique resources such as sound charts and games. In 2016, he launched his

Online Pronunciation Course. Keen to spread his interest in phonetics, he regularly tweets (@ImproveAccent), posts on his blog and makes YouTube videos.

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