

FEATURES OF TABLATURE NOTATION IN THE CURRENT INTERNATIONAL PHONETIC ALPHABET CHART¹

Barry Heselwood

Abstract

Musical tablature notation typically ‘directed the player *what to do with his fingers* than what notes to play’ (Scholes, 1970: 1004, original italics). In this paper, parallels are drawn between tablature notation and the symbolisation of consonants and vowels on the IPA chart by pointing out that they denote what speakers do with their lips and tongues, not what sounds they make. It is argued that while these parallels have probably always been present in phonetic notation, they became definitive when the International Phonetic Association revised its principles after the Kiel Convention in 1989. The effect of the new second principle is to circumscribe the relationship between a speech sound and the symbol representing it, limiting that relationship to one which is much more theoretically-defined and physiologically based where the importance of ostensive definition and experiential knowledge of sound is relegated. As a consequence, what an IPA symbol represents is by definition a specification of what a speaker does, not the sound that is made. This specification is more direct with regard to place of articulation than with regard to manner of articulation. There is an iconic element to the notation as well, which is greater in the case of the vowel chart than the consonant chart. The implications of defining symbols as intersections of articulatory categories are, it is claimed, disadvantageous to the practice of impressionistic phonetic transcription unless it is explicitly acknowledged that a symbol can be used without independent evidence that the articulatory configuration it purports to denote was the one responsible for producing the sound-as-heard. The paper concludes with the suggestion that the second of the seven current principles of the Association may need to be revised so that impressionistic transcription does not have to be carried out using IPA symbols in ways at variance with their definitions. Phoneticians engaged in impressionistic transcription want to be able to acknowledge the IPA as their principal resource without feeling they are deviating from IPA official policy.

1. Introduction

The suggestion that the IPA chart has features of a tablature system of notation does not seem to have been made before. The concept of tablature notation has not featured in analyses of phonetic symbol systems even in cases such as Wilkin’s organic alphabet of 1668, Bell’s *Visible Speech* of 1867 and other ‘organic’ alphabets where it is quite clear that we are looking at systems of tablature in which articulatory postures are explicitly represented, i.e. what the speaker does, not what s/he says. This lack of explicit recognition of organic alphabets as tablatures comes despite attention having always been drawn to their physiological iconicity (e.g. MacMahon, 1996).

In fact, surprisingly little attention has been paid to the question of what kind of symbols IPA symbols are. In typologising notation systems distinctions have been made between alphabetic, iconic and analphabetic notation (see e.g. Abercrombie, 1964; 1967; MacMahon, 1996); symbols in alphabetic systems have also been classed according to their source, e.g. Roman or Greek letters, and according to whether they are ‘monotypic’ or ‘diacritic’ (Albright, 1958: 28). But there is as yet no

¹ Unless otherwise stated, references are to the 2005 version of the chart.

comprehensive typology of the conventions used in phonetic symbolisation, let alone a situating of phonetic symbolisation within a theory of representation in general, or of writing in particular. Of more practical importance to phoneticians has been the question of the availability of an adequate set of easy-to-use symbols for representing aspects of pronunciation, rather than theorising about what exactly the symbols stand for or trying to bring to light the principles according to which they work as symbols.

2. Experiential versus theoretical knowledge

It is usually taken for granted that a symbol stands in some sense for a ‘sound’, and indeed symbols are routinely given ostensible definitions using keywords that contain the sound in question. An ostensible definition of the symbol [p] might be that it stands for the consonantal sound that occurs in the middle of the English word *happy*, or at the beginning of the French word *père*. The keyword approach has been used in presentations of the IPA since Passy published the first list of IPA symbols in 1888 (Passy, 1888). It is prominent in the 1949 *Principles* (IPA, 1949: 11-12) and the 1999 *IPA Handbook* (IPA, 1999: 18-25). Most phonetics textbooks employ keywords to indicate how phonetic symbols are to be used and interpreted. For keywords to work, we do not need to have any knowledge of phonetic theory, witness for example the use of keywords to explain transcription conventions to the lay public in dictionaries. They work by appealing to our knowledge of what the sounds in the language from which the keywords are taken are like, that is to say, knowledge gained from experience of hearing and producing them, not from subjecting them to a theory-driven phonetic analysis. Sweet (1877: 15), for example, took care to select his keywords wherever possible from ‘the better known languages’ of English, French and German, as did Passy (1888), these three languages forming the ‘original cluster’ of IPA languages (MacMahon, 1986: 37). There is however a weakness in the keywords approach, discussed in relation to vowels by Ladefoged (1967: 53-4), centring on the fact that there is often quite a wide range of variation in the pronunciation of keywords across speakers. Keywords, not only for vowels but also for consonants, represent a range of variants, not a precise quality.

Insofar as keywords help make the link between the sounds of everyday spoken language and phonetic theory, they have a very different function from words of ‘exotic’ languages selected to illustrate the linguistic usage of sounds which have already been explained to the reader using terms of phonetic theory. The practice of providing what we might call ‘illustrative words’, as opposed to keywords, is also common in phonetics textbooks, often in the context of demonstrating that a minimal pair contrast dependent on a particular sound distinction exists somewhere in the languages of the world. While keywords take the sound as the known, a point of reference from which to introduce some aspect of phonetic theory, ‘illustrative words’ take the phonetic theory as given and present the sound as something hitherto unencountered, something outside the reader’s experience. That is to say, keywords go from knowledge of a sound to phonetic theory, attaining theoretical understanding via experience. Illustrative words attempt to go the other way – from phonetic theory to sounds. That being said, phoneticians are fully aware that, as Sweet (1906: 4) proclaimed, ‘[T]heoretical knowledge is not enough’. The inclusion of practical phonetics training in the teaching of phonetics continues to be seen as essential for this reason. Experience of what sounds are like from the points of view of both production and perception is highly valued in phonetics alongside an understanding of phonetic theory.

3. The Kiel Convention and Principle 2

There is reason to take the view that the balance between experiential understanding and theoretical understanding of sounds in the context of interpreting symbols on the IPA chart has undergone a significant shift. Comparison of the six principles of the International Phonetic Association as published originally in *ðə fonetik títçər* in 1888, reproduced in 1949 (IPA, 1949), with the seven principles given in 1999 (IPA, 1999: 159-60) discloses a greater emphasis on theory in the latter.

The watershed between the 1949 and 1999 versions of the principles was the Kiel Convention that took place in 1989. In the discussions leading up to Kiel, for which the *Journal of the International Phonetic Association* provided the forum, Ladefoged (1987: 10) put forward the view that IPA symbols represent ‘the choices permitted by the phonetic theory’. The whole slant of the discussions was towards a chart more explicitly theory-driven, a shift that became enshrined in the second of the seven principles recommended at the Convention and subsequently approved by the Association’s Council. According to the new Principle 2, identified as one of the most important changes resulting from the Kiel Convention (IPA, 1989: 67), symbols represent sets of phonetically-defined categories. It is explained by way of example that ‘[p] is a shorthand way of designating the intersection of the categories voiceless, bilabial and plosive’ (IPA, 1999: 159). Clearly one needs to know what these categories are before one can appreciate what the symbol really stands for, and familiarity with phonetic theory is essential for understanding the categories. Ostensible definition will no longer suffice. This is not to say of course that such categories had no status or importance before Kiel. Knowledge of, and classification by, the places and manners of articulation of sounds has traditionally been the basis of phonetic taxonomy because of the strong focus on the physiology of sound production in phonetics (Albright, 1958: 71). It has therefore always been possible to see such systems as systems of tablature. But there is a conceptual difference between on the one hand presenting a symbol and using physiologically-based phonetic terminology to describe how the sound it stands for is produced, which was the case with the pre-Kiel IPA charts, the description acting as a ‘rough’ definition in Abercrombie’s words (Abercrombie, 1967: 124 – see below), and on the other hand presenting a symbol as standing for a conjunction of theoretically defined categories, and *only* standing for that conjunction. The point is that Principle 2 pushes us into starting with the categories and generating sounds from their collisions at points of intersection, rather than starting with the sounds and analysing their production into component parts. There is a shift of balance from analysis to synthesis.

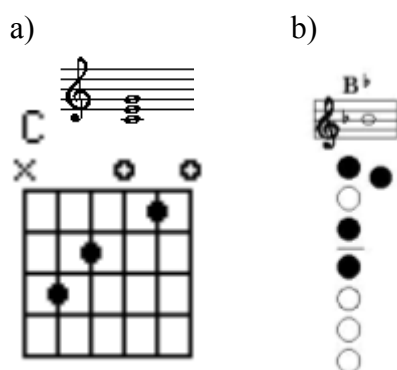
That the introduction of Principle 2 is significant in this respect is evident if we consider further Abercrombie’s remark already alluded to, that the pre-Kiel IPA chart ‘provides *rough* general phonetic definitions for the symbols shown on it’ (italics added). ‘Rough’ definitions cannot be wholly definitive. But the effect of Principle 2 is to take the roughness away and make the definitions properly definitive. Ladefoged (1990: 338) points out, crucially, that this principle means ‘the symbols are *not* symbols for phones’ (original italics) but for bundles of features (i.e. categories). This is the absolutely key point: they are now not symbols for things that can be heard. If the definition of [p] as ‘voiceless, bilabial, plosive’ is exhaustive, then all other properties of observed instances of the sound the [p]-symbol can be used to represent are unnecessary for a [p] to be a [p], including what it sounds like. Having experienced for a lifetime hearing and making the sound that [p] is used as a symbol for no longer means that one understands what the symbol actually represents.

Phonetic categories do not exist outside of a theory and cannot be separately experienced. There is in fact no indication on the chart that sound is implicated at all. The IPA chart would be as true in a silent world as in our world of sound. The categories, at least many of them, denote the actions required for producing the sound, and these actions are symbolised by IPA symbols. Once that is the case, the symbols can then function as a set of instructions for sound production to anyone with sufficient knowledge of phonetics to interpret them. It tells the reader where to put the tongue, what state the glottis should be in, etc. Representing a set of instructions for actions, rather than the outcome of the actions, is the defining feature of musical tablature notation or, more precisely, certain types of tablature notation.

4. Tablature notation

In its widest sense, the term ‘tablature’ in music notation simply means representing all the parts, or ‘voices’, of a piece of music together in a score ‘so that the eye can encompass them’ (Dart, Morehen & Rastall, 2001: 905), but it has for a long time been common to use the term more narrowly for systems of notation that do not use notes on a staff, and more narrowly still for systems that tell the player where to place his/her fingers on the instrument in order to produce a particular pitch. Where this more narrow sense is intended, it is sometimes known as *Griffsschrift* or ‘finger notation’ (Rastall, 1997: 8-9). For fretted string instruments such as the lute or guitar, this means indicating on which fret-string intersections to place the fingers to produce a given note or chord. The strings have to be tuned in such a way that the correct pitches will result but it is important to appreciate that it is not the pitches themselves that are represented in the notation. Players of wind instruments are told which holes to cover to get the desired pitch. Figure 1 gives examples of each type.

Figure 1. a) Staff notation (upper) and guitar tablature (lower) for the chord of C Major; b) staff notation (upper) and recorder tablature (lower) for the note-pitch B flat. Filled circles represent finger placements on the instruments.



Tablatures of the kinds in fig.1 show a diagrammatic representation of the instrument, or relevant part of the instrument, and are therefore iconic. Not all tablature, though, need be iconic. Instead of diagrams, numbers and letters can be used to specify frets and strings (see Rastall, 1997). Again, though, it is not musical pitches that are represented.

In sections 4.1 and 4.2 the extent to which the charts for consonants and vowels on the current IPA chart display features of a tablature system are examined. While the conclusions drawn are also valid for the pre-Kiel versions of the chart, and for many pre-IPA sound charts dating back to Wilkins in the 17th century (see Albright,

1958), tablature interpretation was not the only interpretation possible for a phonetic symbol. Because symbols could be taken to stand for sounds (phones), and not exclusively for intersections of categories set up by phonetic theory, a symbol could be interpreted as of the same kind as a musical note on a pitch-staff². That is to say, it could be said to stand for an auditory quality in a holistic sense with no reference to how it can be produced and without even the requirement of analysis into component parts. The ‘rough’ definitions provided by the articulatory-based dimensions on the chart, not being exhaustive before the adoption of Principle 2, left room for other types of relationship between sound and symbol, including a relationship established through phoneticians’ experiences of listening to sounds.

4.1 The IPA consonant chart

If we think of the musician’s fingers as active articulators, and the frets or holes on the instrument as passive articulators, there is a clear analogy with how phonetic theory describes the production of speech sounds by reference to places of articulation. Tablatures typically represent only the passive articulator, i.e. the fret or hole, it being understood which fingers are the most appropriate to use. Here we have an analogy with the notion of neutral articulation in phonetics (Laver, 1994: 137). Only passive articulators are specified on the IPA chart for neutrally-articulated consonants. The relevant active articulator for a neutral articulation is taken to be the one lying opposite (IPA, 1999: 7-8). Albright (1958: 72) identifies some of the terms down the lefthand side of the IPA chart, i.e. the manner of articulation features, as ‘acoustic properties’. Those closest to being acoustic, or auditory, properties are probably ‘plosive’ and ‘fricative’, but they refer primarily to modes of airflow and are thus better considered aerodynamic terms. Properly auditory categories have never been a feature of the IPA nor of phonetics in general despite one or two attempts to introduce them, e.g. Pilch (1978); one notable exception has been the Cardinal Vowels of Daniel Jones, although even here there has been no lack of ambivalence between auditory and articulatory definitions (Butcher, 1982). Nevertheless, terms such as ‘plosive’ and ‘fricative’ cannot be interpreted as direct instructions to the speaker in the way that the place of articulation terms can. They are indirect instructions in that the speaker has to know which degrees of approximation will create plosion and friction. Similarly, ‘nasal’ is not directly an instruction to open the velopharyngeal port. We therefore cannot characterise the whole consonant chart as a direct system of tablature of the *Griffsschrift* type, only the top row and perhaps such manner terms as ‘tap’, ‘flap’, ‘approximant’ and ‘lateral’. However, it is clear that the top row specifies locations on a sound-producing mechanism where contact can be made in order to produce sounds with particular qualities, precisely what *Griffsschrift* tablature does. Each consonant symbol stands for a pattern of contact at one or more of these specified locations. Because the locations are set out according to their relative positions in the vocal tract, left to right from bilabial at the front through to glottal at the back, the place-of-articulation dimension of the chart is iconic. The order of rows on the chart can also be seen as iconically motivated insofar as the more open degrees of stricture tend to be towards the base. The foregoing observations justify the conclusion that the IPA chart for pulmonic consonants has features of an iconic tablature notation system.

² While the defining auditory property of a musical note is its pitch, timbre being determined by which instrument it is played on, for a speech sound the defining auditory property is timbre.

The smaller table for non-pulmonic consonants, appearing separately on charts since the 1993 revisions, is set out rather differently. Places of articulation are given vertically with front at the top and back at the bottom; manner of articulation is given across the top.

4.2 The IPA vowel chart

The representation of vowels on the IPA quadrilateral, adapted from the Cardinal Vowel system and corresponding charts developed by Daniel Jones (Jones, 1976: 31-9) which in turn was based on what Catford (1981: 19) calls the ‘Bell-Sweet’ model, is more thoroughly a tablature type of representation than the consonant chart. Although it is not as precise in specifying locations for tongue placement as the consonant chart, a vowel symbol nevertheless purports to represent a sub-area of the vowel space defined not only in the front-back dimension but also in the high-low (close-open) dimension. Added to this is a specification of the required lip posture in the spread-rounded dimension. According to Principle 2, a vowel symbol on the quadrilateral is to be defined exhaustively as an intersection of a tongue height, a tongue frontness or backness, and a lip posture. It can therefore be interpreted as a set of instructions to a speaker about where to place the tongue and how to shape the lips to make a given vowel sound. Serious doubts have often been expressed about how accurate the quadrilateral is in relating vocal tract configurations to acoustic and auditory qualities (e.g. Ladefoged, 1967; Butcher, 1982; for doubts that Jones himself may have had about his Cardinal Vowel system, see Collins & Mees, 1999: 188-92), but this is a separate matter from what kind of symbolisation system the IPA vowel quadrilateral actually is. These misgivings may, however, be responsible for what appears as a contradiction to Principle 2 in the IPA *Handbook* (IPA, 1999: 11-12) when it says that ‘[T]he use of auditory spacing in the definition of these vowels means vowel description is not based purely on articulation’. But there are no categories that relate to auditory spacing on the vowel chart – all the categories whose intersections, according to Principle 2, define what the vowel symbols stand for are articulatory.

The design of the quadrilateral is iconically motivated even more so than the consonant chart. Not only does the left-right axis represent the front-back dimension of the vowel space, but the top-bottom axis also systematically represents the high-low/close-open dimension. Lip posture is not, however, iconic; where there is a pairing of symbols, the left-hand one denotes spread lips, the right-hand denotes rounded lips, the same convention that distinguishes voiceless from voiced consonants on the consonant chart.

4.3 Implications for impressionistic phonetic transcription

A symbol that denotes only an articulatory configuration cannot be meaningfully used to denote an auditory quality unless there is a fixed one-to-one relation between them. But there are reasons to seriously question this on several counts. Experimental evidence reported in Butcher (1982: 62) shows that the languages a listener speaks, and even the listener’s age, can influence the way a particular speech sound is heard. An auditory experience is not, then, simply determined by the acoustics of the stimulus. Concerning the reverse relation, many studies have concluded that the same acoustic structure and the same auditory quality can be produced by more than one articulatory configuration (e.g. Ladefoged, Harshman, Goldstein & Rice, 1978; Maurer, Gröner, Landis, Hoch & Schönle, 1993; Perkell, 1997). A particular case in point concerns the American English /r/ for which two types of free-variant

allophones have been identified – a retroflex [ɭ] and a ‘bunched’ or ‘molar’ variant in which the tongue-tip is not raised but remains down and is retracted into the body of the tongue. The IPA does not provide a separate symbol for the bunched type; Laver (1994: 301-2) has suggested [ɸ] but the suggestion does not appear to have been widely taken up. The two types are reportedly indistinguishable to the ear and to acoustic analysis. Espy-Wilson, Boyce, Jackson, Narayanan & Alwan (2000: 345) claim that in fact ‘these two categories are only the extremes in a continuum’, thus underscoring the many-to-one relation of articulation to auditory-acoustic quality. Given this state of affairs, IPA symbols in narrow impressionistic phonetic transcriptions are, strictly speaking, meaningless unless the articulatory configurations have been verified, but this is at best highly impractical and at worst completely impossible. Principle 2, if interpreted to the letter, effectively removes IPA symbols from the set of tools available to phoneticians wishing to make impressionistic transcriptions and renders the concept of an auditory IPA transcription a contradiction in terms. The only way round this problem is to recognise some truth in Russell’s (1928) observation that ‘phoneticians are thinking in terms of acoustic³ fact and using physiological fantasy to express the idea’ (Russell, 1928, cited in Ladefoged, 1967: 72, though see Catford 1981 for a different perspective on this). As Howard & Heselwood (2002: 388-9) point out, because of the articulatory definitions of IPA symbols, when we choose a symbol to record an auditory impression we will have brought phonetic theory and informed conjecture to bear to decide which articulatory configuration was most likely to have produced the sound heard. In using the symbol [p] when transcribing an audio recording, for example, we are not stating that the speaker made a bilabial closure because we are not in a position to testify to that, only that we heard a sound *that sounded as if* it was made with a bilabial closure. The kind of relationship between sound and symbol implied by the ‘*sounded as if*’ qualification is more consistent with a chart that supplies ‘rough’ definitions than one that claims to supply exhaustive definitions. It leaves room for transcribers to exploit their auditory experience of sounds when deciding which symbols to use, which is what transcribers have always done and always will do. Phonetic transcription will be unable to express what a piece of speech sounds like if its purpose is, as Shriberg & Kent (2003: 3, italics added) have stated it, ‘to represent the *production* of speech sounds’.

Returning to the analogy with musical tablature, we might imagine a situation in which the tablatures in figure 1 could be used to represent pitches of the kind that, because of our knowledge of those musical instruments, *sounded as if* they were made with those particular finger positions but may in fact have been made with different finger positions. The point is that a particular articulatory configuration should not be a pre-requisite for the use of a symbol when we wish to record an auditory impression, all the more so when we are not able to determine the articulatory configuration and when research has convinced us that knowing what properties a sound has in one of the domains of phonetics (articulatory, acoustic, auditory) is no sure guide to what properties it has in another domain. Fifty years ago, in discussing impressionistic transcription, Hammarström (1958: 34, italics added) wrote: ‘If a listener hears the same sound twice and if it is shown that the two sounds were articulated quite differently, *this information is obviously irrelevant on the auditory level.*’ Principle 2 unfortunately makes it not just highly relevant but a matter of absolute and uncompromising importance.

³ In keeping with the usage of the time, we can take it that Russell meant ‘auditory’.

5. Conclusion

The adoption by the International Phonetic Association of Principle 2 following the Kiel Convention of 1989 seems to have significantly moved what it means to understand a phonetic symbol from a more experiential to a more theoretical basis. The traditional physiological bias of phonetic theory means the change has brought with it the consequence of more firmly establishing the IPA charts as systems of tablature of the *Griffsschrift* type. Indeed, it has made it impossible to regard the vowel chart as anything but a tablature without contradicting the principle. Because IPA symbols cannot be interpreted except by reference to where they occur on the chart, the symbols themselves have to be interpreted in tablature terms. It is like using the symbol-expression 'B \flat ' to represent not the musical pitch of B flat, but the recorder tablature in figure 1 so that one does not have to reproduce the diagram every time (although the iconicity is lost). If, for some reason, the resulting sound is not what is expected, that would be no reason to change the symbol because it is not the sound that is represented, only the finger positions. Returning to the phonetic situation described above by Hammarström, tablature definitions of symbols would mean that two different symbols would have to be used. Listener-oriented impressionistic transcription could not proceed under this obligation.

The identification in this paper of features of tablature notation in the current IPA chart provides a dimension for typologising phonetic notation systems according to whether they denote what the speaker does or what s/he produces. This does not relate to the symbols themselves as graphic shapes but to what they represent and thus to how they are to be interpreted. Any comprehensive typology of phonetic notation will need to take account of tablature features.

Finally, the practice of impressionistic transcription is undermined if symbols are defined exclusively in tablature terms. If impressionistic transcription is to continue to be practised in areas of investigation where it is valued, such as speech pathology, dialectology, sociophonetics and forensic phonetics, then Principle 2 may need to be revised to allow for IPA symbols to denote sounds-as-heard in the absence of independent articulatory information. It is, after all, only sounds-as-heard that can have any linguistic, social-indexical or interaction-regulating value in spoken communication.

References

- Abercrombie, D. (1964) *English phonetic texts*. London: Faber & Faber.
- Abercrombie, D. (1967) *Elements of general phonetics*. Edinburgh: Edinburgh University Press.
- Albright, R.W. (1958) *The International Phonetic Alphabet: its backgrounds and development*. Bloomington: Indiana University Press.
- Butcher, A. (1982) Cardinal vowels and other problems. In Crystal, D. (ed.) *Linguistic controversies*. London: Arnold. Pp.50-72.
- Catford, J.C. (1981) Observations on the recent history of vowel classification. In Asher, R.E & Henderson, J.A. (eds.) *Towards a history of phonetics*. Edinburgh: Edinburgh University Press. Pp.19-32.
- Collins, B. & Mees, I.M. (1999) *The real Professor Higgins: the life and career of Daniel Jones*. Berlin: Mouton de Gruyter.
- Dart, T., Morehen, J. & Rastall, R. (2001) Tablature. In Sadie, S. (ed.) *The New Grove Dictionary of Music and Musicians*. 2nd edition, Vol 24. Pp.905-14.
- Espy-Wilson, C.Y., Boyce, S.E., Jackson, M., Narayanan, S. & Alwan, A. (2000)

- Acoustic modeling of American English /r/. *Journal of the Acoustical Society of America* 108, 343-56.
- Hammarström, G. (1958) Representation of spoken language by written symbols. *Miscellanea Phonetica* III, 31-9.
- Howard, S.J. & Heselwood, B. (2002) Learning and teaching phonetic transcription for clinical purposes. *Clinical Linguistics & Phonetics* 16, 371-401.
- IPA (1949) *The principles of the International Phonetic Association*. London.
- IPA (1989) Report on the 1989 Kiel Convention. *Journal of the International Phonetic Association* 19, 67-80.
- IPA (1999) *Handbook of the International Phonetic Association*. Cambridge: Cambridge University Press.
- Jones, D. (1976) *An outline of English phonetics*. Cambridge: Cambridge University Press. 9th revised edition.
- Ladefoged, P. (1967) The nature of vowel quality. In Ladefoged, P. *Three areas of experimental phonetics*. Oxford: Oxford University Press. Pp. 50-142.
- Ladefoged, P. (1987) Updating the theory. *Journal of the International Phonetic Association* 17, 10-14.
- Ladefoged, P. (1990) Some reflections on the IPA. *Journal of Phonetics* 18, 335-346.
- Ladefoged, P., Harshman, R., Goldstein, L. & Rice, L. (1978) Generating vocal tract shapes from formant frequencies. *Journal of the Acoustical Society of America* 64, 1027-35.
- Laver, J. (1994) *Principles of phonetics*. Cambridge: Cambridge University Press.
- MacMahon, M.K.C. (1986) The International Phonetic Association: the first 100 years. *Journal of the International Phonetic Association* 16, 30-38.
- MacMahon, M.K.C. (1996) Phonetic notation. In Daniels, P.T. & Bright, W. (eds.) *The world's writing systems*. New York: Oxford University Press. Pp. 821-46.
- Maurer, D., Gröne, B., Landis, T., Hoch, G. & Schönle, P.W. (1993) Re-examination of the relation between the vocal tract and the vowel sound with electromagnetic articulography (EMA) in vocalizations. *Clinical Linguistics & Phonetics* 7, 129-43.
- Passy, P. (1888) Our revised alphabet. *The Phonetic Teacher*. August-September, 57-60.
- Pilch, H. (1978) Auditory phonetics. *Word* 29, 148-60.
- Perkell, J.S. (1997) Articulatory processes. In Hardcastle, W.J. & Laver, J. (eds.) *The handbook of phonetic sciences*. Oxford: Blackwell.
- Rastall, R. (1997) *The notation of Western music*. Leeds: Leeds University Press. 2nd edition.
- Russell, G.O. (1928) *The vowel*. Columbus: Ohio State University Press
- Scholes, P.A. (1970) *The Oxford companion to music*. Oxford: Oxford University Press. 10th edition.
- Shriberg, L.D. & Kent, R.D. (2003) *Clinical phonetics*. Boston: Allyn & Bacon. 3rd edition
- Sweet, H. (1877) *A handbook of phonetics*. Oxford: The Clarendon Press.
- Sweet, H. (1906) *A primer of phonetics*. Oxford: The Clarendon Press. 3rd revised edition.

Barry Heselwood
 Dept of Linguistics and Phonetics
 School of Modern Languages and Cultures

University of Leeds
LEEDS LS2 9JT

b.c.heselwood@leeds.ac.uk