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**Peter Ladefoged's contribution to phonology and phonetics**

**Preamble**

Peter Ladefoged died of a stroke on January 24, 2006 in London, England. His passing at the age of 80 marks the end of a particular era as he was one of the leading phoneticians of the second part of the twentieth century and contributed to the field right to the end of his life.

Peter Ladefoged (PL hereafter) was born in England (Sutton, Surrey) on September 17, 1925. His University education was at Caius College, Cambridge, and then at Edinburgh University where he obtained an MA in 1951. It was there that PL came under the influence of David Abercrombie who supervised his PhD (awarded in 1959). Through Abercrombie, PL was introduced to the descriptive and practical tradition of British phonetics which stretches back to Henry Sweet via Daniel Jones. (Indeed, he served as the linguistic consultant during the making of the film 'My fair lady', based on G.B. Shaw's *Pygmalion*). Some of the pedagogical skills he developed can be traced back to this period and very many students of linguistics and phonetics owe a great deal to his manuals such as *Elements of Acoustic Phonetics* (1962, 2nd edition, *A Course in Phonetics* (1975, 6th edition 2006), and more recently *Vowels and Consonants* (2001) and *Phonetic Data Analysis* (2003). As pointed out by Patricia Keating, '(T)he thousands of UCLA students who took Linguistics 1 from Peter Ladefoged probably had no idea that their professor was the president of the Linguistic Society of America or the International Phonetic Association, but they knew why he had won the UCLA Distinguished Teaching Award' (quoted in Stuart Wolpert' obituary note, 2006).

As noted later, most of PL's career took place in the United States. But apart from Edinburgh, he also held a one-year teaching position at the University of Ibadan in Nigeria (1959-1960). In the wake of this stay, he conducted in Africa what is probably the most extensive phonetic survey ever realized. He examined 61 languages with a wide range of instrumental techniques and published the results in a famous monograph *West African Languages: an auditory-instrumental survey* (1964, 2nd edition 1968). As Stuart Wolpert put it: 'The work also presented to the world one of Peter's most important scholarly principles - that we should not be satisfied to contemplate what we have heard as linguists, before we have traveled the world to hear what there is to be heard'. This book certainly established PL's reputation as one of the foremost fieldworkers in the areas of descriptive and experimental phonetics. Again, right until the end of his life, he went on working on endangered languages and made this one of his priorities even if he was capable of unconventional views on the subject (PL 1992). One major achievement reflecting PL's extensive examination of languages, is the publication of *The Sounds of the World's Languages* (1996) in collaboration with Ian Maddieson. This work based on data and analyses of nearly 400 languages is probably the most significant book in phonetics of the end of the twentieth century.

To go back extremely briefly to PL's professional life, he became an assistant professor of phonetics at UCLA in 1962 where he founded and headed the famous UCLA Phonetics Laboratory. He held various prestigious positions regionally, nationally and internationally: among other things, he was made President of the Permanent Council for the Organization of International Congresses of Phonetic Sciences in 1983 (serving until 1991), and was President of the International Phonetic Association in 1987 (serving until 1991).

His theoretical work was developed within the North-American context and his work will be particularly remembered in the area of distinctive features where he was the author of a full-blown alternative to the system put forward by Chomsky and Halle in the *Sound Pattern of English*. His insistence on the need to take fully into account acoustic/auditory parameters beside articulatory ones will remain important. But the purpose of the above paragraphs was not to give an exhaustive survey of his life and contribution to the field but to lead to an examination of his work. We can mourn the passing of a great phonetician but one way of paying respect to his memory is to examine his work and engage with him in debate over the nature of phonetic and phonological generalizations.

I will do so by examining three central areas of his work: (1) The Nature of Vowel Quality, (2) the IPA and the theory of distinctive features, (3) Production, perception, cognition and phonological units. These questions do not by any means exhaust PL's production. His contribution to fieldwork and to typology or his contribution to experimental phonetics would justify detailed separate discussion.

## 1. The early work: vowels, stress and the perception / production of speech

Many specialists of linguistics know PL's work through his textbook and his later work. To understand fully his thinking it is however necessary to go back to his early work.

### 1.1. The Nature of Vowel Quality

The phonetic description of vowels was the focus of some of PL's early work and remained central to his view of phonetics and phonology throughout his career. The early work is most conveniently summarised in 'The nature of vowel quality', ch. 2 of PL 1956. This chapter of *Three areas of experimental phonetics* is closely based on Broadbent and Ladefoged (1957, 1960), Ladefoged (1956, 1960).

Terms like 'vowel' and 'consonant' are obviously pretheoretical but nevertheless useful in phonetics and phonology for describing sounds. It is well known that these terms conflate two dimensions : one related to the quality of the sound definable either in articulatory or acoustic/auditory terms (cf. Pike's (1943) distinction between 'vocoids' and 'contoids'), the other one related to position within sequences (cf. the distinction between syllabic and non syllabic segments). Let us assume along with PL that what we mean by vowel is a 'syllabic vocoid' in Pike's sense.

Vowels have always proved more difficult to describe in articulatory terms than sounds which involve more extreme strictures (such as fricatives or stops) and which are usually described as consonants. Various descriptive schemes have been put forward throughout the centuries and PL offers a brief statement of these in the wake of Abercrombie's well-known work on this topic.

In the nineteenth century, a number of authorities converged on the idea that the most common dimensions were vowel height, vowel backness (or frontness) and lip-shape. Regarding vowel height, two positions, which have remained important to this day, were clearly delineated. The first one was adopted by Alexander M. Bell and Henry Sweet and will be referred to as the Bell/Sweet view. It anticipates the binary systems which have figured prominently in the literature ever since Jakobson, Fant and Halle's (1952) groundbreaking

contribution: *Preliminaries to Speech Analysis*. The second one will be referred to here as the IPA view and will be covered later.

Although a number of schemes for classifying vowels have been in existence for centuries, PL notes that Bell's 1867 approach was novel in a number of respects. It appeared to describe the position of the tongue in two dimensions, which were each ternary: height (high, mid, low) and backness (front, mixed, back). This yielded nine cardinal positions (with what seems the first use of the term 'cardinal' in the description of vowels). However, this model was not as straightforward as often assumed: it was not a simple height of the tongue model given, on the basis of Bell's diagrams, high and low mixed vowels appear to involve a hollowing in the middle of the tongue. As observed by Ladefoged, although Bell's auditory observations were far better than those of his predecessors, even a cursory glance at his display of vowel articulations reveals that his knowledge of articulations were not much greater.

In addition to tongue position, Bell offered two other parameters: (i) degree of opening of the lips (rounded-unrounded) and (ii) the opening between the back of the mouth and the throat (primary vs. wide) - a parameter which seems to be the antecedent of modern Advanced/Retracted Tongue Root (ATR hereafter). Sweet adopted the same basic scheme but modified the definition of primary/wide, which he calls narrow/wide. For him, this parameter depends on the *shape* of the tongue. 'In forming narrow sounds there is a feeling of tenseness in that part of the tongue where the sound is formed, the surface of the tongue being made more convex than its natural 'wide' shape, in which it is relaxed and flattened' (1877: 8-9). As can be seen in Fig. 1, taken from Sweet's *Handbook of Phonetics*, such a supplementary feature allows 36 vowel qualities to be distinguished as in Bell's description.

| NARROW | | | WIDE | | |
|---|---|---|---|---|---|
| ∀ high-back | **ih** high-mixed<br>N. Welsh tag*u* | **I** high front<br>F. f*i*n*i* | **A** high-back | ***i*h** high-mixed<br>Occ. E. pretty | ***i*** high-front<br>E. b*i*t |
| **ɐ** mid-back<br>E. b*u*t | **eh** mid-mixed<br>G. gab*e* | **E** mid-front<br>F. *été* | **a** mid-back<br>E. f*a*ther | ***e*h** mid-mixed<br>E.*e*ye (*e*h[ih]) | ***e*** mid-front<br>Danish tr*æ* |
| **ɒ** low-back<br>Occ. Sc. B*u*t | **æh** low-mixed<br>E. b*ir*d | **æ** low-front<br>E. *ai*r | ***ɑ*** low-back<br>Sc. F*a*ther | **æh** low-mixed<br>E.how (*æ*h[oh]) | ***æ*** low-front<br>E. m*a*n |
| **NARROW-ROUND** | | | **WIDE-ROUND** | | |
| **u** high-back<br>F. s*ou* | **uh** high-mixed<br>Swedish h*u*s | **y** high front<br>F. l*u*ne | ***u*** high-back<br>E. f*u*ll | ***u*h** high-mixed<br>Swedish *u*pp | ***y*** high-front<br>G. schützen |
| **o** mid-back<br>G. s*o* | **oh** mid-mixed | **ə mid-front**<br>F. p*eu* | ***o*** mid-back<br>N.G. st*o*ck | ***o*h** mid-mixed<br>F. home | ***ə*** mid-front<br>N. G. schön |
| **ɒ** low-back<br>E. s*aw* | **ɔh** low-mixed | **œ** low-front<br>E. *ai*r | ***ɔ*** low-back<br>E. n*o*t | ɔh low-mixed | ***œ*** low-front |

Fig. 1 Sweet's (1877: 16) basic organization of the vowel space

Incidentally, Sweet also posited a shifted position of these 36 qualities, which allowed him to specify 72 vowel qualities. All these qualities were defined in articulatory terms but as pointed out by Ladefoged, it is often difficult to understand what Sweet meant. It is likely that, given his excellent ear, Sweet was devising categories which would accommodate the auditory distinctions he could perceive.

Both Jakobson, Fant and Halle (1952) and Chomsky and Halle (1968) have followed the Bell/Sweet tradition regarding vowel height. That is, they offer schemes in which only three positions are allowed. Whenever a language appears to allow for more degrees of height or advancement/retraction (backness hereafter), this has to be handled in terms of other features: typically tense/lax (Jakobson, Fant and Halle, 1952, Chomsky and Halle 1968) or ATR in more recent work. It is interesting to note that this position is maintained in Kenstowicz's 1994 textbook, although the latter allows for three degrees of backness whereas this dimension is seen as binary in SPE. In so far as Kenstowicz's manual can be considered as the state of the art for generative phonology at the end of the twentieth century, we seem to have come back full circle to the Bell/Sweet position. (Incidentally, Kenstowicz fails to point out a curious consequence of his position. If tongue height is to be specified in terms of a 'neutral position' defined in SPE as that of a mid front vowel (more or less like the [e] in *bed*) from which raising or lowering yields high and low vowels, we have to modify our starting point if we wish to allow for three degrees on the front-back axis. The neutral position ought to be closer to a schwa. A lot of linguists might well applaud such a change, but it does seem to show the artificiality of the SPE neutral position: it appears to be merely a convenient reference point from which we project the features we need, not an independently established physiological configuration. However that may be, let us turn to the other tradition of vowel description, that of the IPA.

The IPA vowel description is attributed by Ladefoged in 'The Nature of Vowel Quality' to Daniel Jones, who gave a precise definition of vowel space in terms of his 'cardinal vowels'. As shown by a quote given here later, the IPA position antedated Jones' contribution and owed a great deal to the French founder of the IPA, Paul Passy. Let us, however, leave history aside to concentrate on Jones' cardinal vowels which were the object of Ladefoged's investigation. From now on the expression 'the cardinal vowels' will refer exclusively to Jones' system.

Jones' proposal was first presented in *An English Pronouncing Dictionary* (1917) and in *Outline of English Phonetics* (in the second 1922 edition [JON 64]) and then integrated to the *Principles of the International Phonetic Association* de 1949. A particularly clear and succinct presentation of the cardinal vowels is to be found in Jones' *The Pronunciation of English*, which is either quoted or paraphrased in what follows. The cardinal vowels are 'specially selected points of reference from which other vowels can measured' (p. 18). The system which Jones considered to have given the best results was a system of eight vowel sounds: [i e ɛ a ɑ ɔ o u] said to be primary and numbered from 1 [i] to 8 [u] : CV1[i], CV2 [e], CV3 [ɛ], CV4 [a], CV5 [ɑ], CV6 [ɔ], CV7 [o], CV8 [u]. They were selected in the following way : 'No. 1 is the vowel which combines the greatest degree of 'closeness' with the greatest degree of frontness'. It is not possible to make a 'fronter' vowel ; and if the tongue were raised any higher, normal breath pressure would give rise to a frictional noise and the sound uttered would not be a vowel at all. No 5 combines the greatest degree of 'openness' with the greatest degree of 'backness'. The tongue is incapable of being lower, and if it were retracted further a frictional noise would be produced by the air issuing through the narrow space between the back of the tongue and the back part of the mouth : it would be a consonant namely the sound represented by [R].' On the basis of these two 'hinges' (cf. Latin 'cardo'), cardinal vowels Nos 2, 3, and 4 are 'vowels of the 'front' series selected as to form (as nearly as can be judged by ear) equal degrees of acoustic separation between Nos. 1 and 5. Nos. 6, 7 and 8 are selected so as to continue these equal degrees of acoustic separation in the back series of vowels (as nearly as can be judged by ear).' (pp. 19-20).

Jones then displays the vowels in conventional diagrams which have the shape of a trapezium. He also gives stylized mid-sagittal views of the speech organs presented as 'approximate tongue positions of the cardinal vowels'. They form what can be called the 'tongue-arch' theory of vowel production in which the labels close (or high), close-mid (mid-high), open-mid (mid-low) and open (low) are assumed to denote the location of the highest point of the tongue within the oral cavity. Lip-rounding, which is separable from the two axes so far considered is integrated within the system as follows : in the primary cardinal vowels, the lip-position changes progressively from full lip-spreading for CV1 to close lip-rounding for CV8. A secondary set of cardinal vowels, [y ø œ ɶ ɒ ʌ ɤ ɯ] (numbered 9 to 16), can be obtained by reversing the lip-rounding of the primary set.

Jones does concede that the assumed articulatory positions are approximate ones and that the representations adopted are above all convenient in practical language teaching. But, in case readers should be assailed by doubts as to the fit between auditory and articulatory equidistance, they are told that '(T)he positions of Nos 1, 4, 5 and 8 have been ascertained by X-ray photography' (given in the frontispiece). In fact, as pointed out by Ladefoged, it was known quite early on that tongue positions even in cardinal vowels did not match the assumptions made by Jones and many other linguists. From the measurements in mm of the distances between the highest point of the tongue in the only published X-ray photographs of a complete set of authentic cardinal vowels (cf. S. Jones 1929), it is apparent that the distances are in no way equidistant. As shown in Ladefoged's Figure 30 (op. cit. p. 71) [ɔ] and [o] have the same tongue height and the interval between [i] and [e] is shorter than that between [e] and [ɛ] or [ɛ] and [a].

Although PL never thought that the physiological data were irrelevant, he reminds us that, as far as vowels are concerned, Russel's warning 'phoneticians are thinking of acoustic fact and using physiological fantasy to express the idea' (1928) has never been taken seriously enough. Jones himself was aware of the difficulties facing his system as the following quote shows from PL's review of Berveley Collins & Inger M. Mees *The real Professor Higgins : The life and career of Daniel Jones* (Berlin & New York : Mouton de Gruyter, 1999):

'One of Jones's most well known achievements is the cardinal vowel system, in which vowels are specified in terms of their relation to eight precisely defined vowel sounds. C&M [Berverley Collins & Inger M. Mees] give a thoughtful account of the development of this system, pointing out that its roots go much further back than is commonly realized. They show how 'Passy ... can be seen as the direct inspiration of Jones's version of tongue arch theory' (180). This point has been overlooked by many writers on the history of phonetics, myself included. They also discuss his problem of reconciling the notion of auditory equidistance between cardinal vowels with the notion of equal steps in tongue movement. They point out that these notions cannot be reconciled, but Jones nevertheless persisted in looking for physiological evidence that would support his theory. Daniel Jones himself published x-ray photographs of only four of his cardinal vowels although, as he told me in 1955, he had photographs of all eight 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'.' (PL 2000 : 192)

One of the difficulties is that Daniel Jones, who has left us a number of outstanding descriptions of various languages, including English of course, was over-confident in his auditory capacities as shown by the following anecdote quoted in PL's *Phonetic Data Analysis* (2003: 27): 'When Daniel Jones, the greatest phonetician of the first part of the

twentieth century, was setting out on a fieldwork trip, a reporter asked him, 'Professor Jones, what instruments are you taking with you ?' He pointed to his ears and said, 'Only these.' As Ladefoged points out, 'There is no doubt that the ultimate authority in all phonetic questions is the human ear. But nowadays instrumental aids can often illuminate particular points, acting like a magnifying glass when we need to distinguish between two similar sounds'.

What PL does in 'The nature of vowel quality' is probe the acoustic and auditory structure of vowels. Part of the experimental work is based on recordings of primary cardinal vowels in various pitches by eleven very experienced phoneticians who were all University of London faculty members. Daniel Jones took part in the experiment, supervised the recordings and finally selected 31 sets, so that there were for each of the eleven phoneticians at least two and, if possible, three sets of vowels considered to be good exemplifications of the cardinal vowels not in the extreme pitch ranges. PL then proceeded to an acoustic analysis, mainly in terms of formant structure, of the 248 recorded vowels (i.e. 31 sets times 8 cardinal vowels). The results confirm that 'The acoustic structure of most vowel sounds can be conveniently specified by stating the frequencies of their first two or three formants' (p. 132). They do not however yield a completely satisfying picture since PL proceeds to state 'This is not true of vowels which are called in traditional terms close vowels, nor of so-called back vowels. It is not easy to analyse these vowels in terms of their formants'. The study also shows that the feeling of auditory equidistance between the primary cardinal vowels is not fully supported. The interval between each of the first five cardinal vowels [i e ɛ a ɑ] is generally greater than that between each of the last four [ɑ ɔ o u]. While one might draw the conclusion that the cardinal vowel system should therefore be seriously questioned, PL does not go that far. He presents an experiment in which eighteen phoneticians were asked to plot the vowels in ten Gaelic words spoken by a native Gael. Fifteen of the subjects had been trained in the British IPA tradition and had extensive practice of working with cardinal vowels. The other three very experienced phoneticians were well acquainted with the system but had not undergone the rigorous Jonesian training procedure. None of the subjects was acquainted with the variety of Gaelic used in the experiment. The results show that while the labels and plottings provided by all phoneticians can be questioned, the subjects trained in the British tradition were more in agreement than those of the other phoneticians. PL concludes : 'At the moment the best means of providing these reference points is by oral instruction in the cardinal vowels; consequently ; in the present state of our knowledge to abandon the cardinal vowel system is to abandon the only internationally known method of specifying vowels at all accurately' (p. 142). This will explain to readers of PL's textbooks why his description of vowels has always included a presentation of the cardinal vowel system.

PL also probes the perceptual quality of vowels through a perceptual experiment which was quite innovatory in that it involved synthetic speech and established (p. 133) that 'The perceptual quality of a vowel usually depends on the relationship between the pitches of the formants of that vowel and the pitches of the formants of other vowels pronounced by the same speaker' and 'The listener to speech uses his past experience to form an adaptation level, the immediate past experience of a particular voice being the post important factor in this process' (with the caveat already mentioned concerning close vowels and back vowels).

Later work by PL was to reinforce the assumption that the best treatment of vowels is in terms of acoustics/auditory parameters rather than articulation. Ladefoged and Maddieson (1996) gives an overview of various ways of accounting for the vowel space in terms of distances from various anatomical reference points. None of them gives results which can be as satisfactory as plots based on formants and the relationship between them. It should perhaps

be noted that PL's original work on formant structure expressed more reservations than later work. Moreover plotting the vowel space on the basis of formants does not really yield neat and tidy pictures but this is another issue on which we return later.

### 1.2 The nature of stress

PL's reputation as an experimentalist was largely established on the basis of his work on stress, which is extensively surveyed in Ch. 1 of *Three Areas*. This chapter, as pointed out by PL, is a consolidated account of Draper, Ladefoged and Whiteridge 1957, 1958, 1960, Ladefoged and Mc Kinney 1963, as well as Ladefoged 1960, 1962, 1963, 1964.

When these investigations into stress took place one well-known and thought-provoking theory was that put forward by Stetson in *Motor Phonetics* (1951). For Stetson, syllables were to be analyzed as 'ballistic chest pulses' produced by the action of the internal intercostal muscles and a stressed syllable was a 'reinforced chest pulse' - i.e. the action of the internal intercostal muscles was assumed to be reinforced by the abdominal muscles, led by rectus abdominis. These conclusions were challenged by PL (and his collaborators) on the basis of extensive use of electromyography - a new technique in experimental phonetics at the time (see Fromkin and Ladefoged 1966).

A number of conclusions are drawn by PL. First of all, syllables cannot be correlated in any direct way with particular physical gestures nor for that matter properties of the signal. Although PL always thought that syllables were linguistically motivated their physical underpinnings remained for him an open issue. It is no accident, therefore, that in his 1971 set of distinctive features (see section 2.2) a feature such as +/-syllabic bears the mention: "correlates undefined". Contrary to what was affirmed by Stetson, the activity of the intercostal muscles and their state of tension cannot not be directly linked to syllabic divisions. Thus, a single increase in tension can span a group of articulations, for instance whole words such as *pity* or *around*; on the other hand, one can observe two separate bursts of activities in words such as *sport* or *stay* and other words beginning with a fricative followed by a plosive. Not surprisingly, the syllabic structure of words like *sport* has been a subject of controversy in modern phonology with some researchers going as far as to invoke 'magic licensing' to cover such cases (see Kaye 1992).

Stress, of course, has physiological correlates but they do not support Stetson's model. If we examine pairs of words with contrasting stress such as <u>per</u>vert (N) vs. per<u>vert</u> (V), increases in subglottal pressure, accompanied by intonation changes, do indicate stress but there is only one peak of pressure for the whole word and not two peaks (one corresponding to Stetson's 'reinforced chest pulse' for a stressed syllable and one to the unstressed syllable). More generally, the muscular activity that could be observed was not in agreement with Stetson's model. No evidence could be found for his belief that rectus abdominis reinforced the action of the internal intercostals in stressed syllables. In normal conversation English, the abdominal muscles would appear to be in action only in very long utterances.

'I hope that the data presented here will show conclusively that stress is a gesture of the respiratory muscles, and that it can be specified in terms of the amount of work done in the lungs. It is true that the situation is complicated by the variations in the activity of the respiratory muscles which can be correlated with the linguistically irrelevant factor of the amount of air in the lungs; and by variations associated with particular consonants and particular pitch contours. Nevertheless, the work reported here should make it quite plain that

linguistic stress is a measurable bodily activity. From the point of view of the teacher of pronunciation as well as that of a linguist analysing speech we should consider stress to be more than something we hear; it is something we do' (*Three Areas*, Preface pp. i-ii)

## 2. The IPA and the theory of distinctive features

### 2.1 The IPA

One of the most welcome aspects of Peter Ladefoged's work was to connect the work on the international alphabet and the theory of distinctive features. A number of phoneticians have seen phonetic description as at odds with distinctive feature theory. For instance, Catford in his remarkable 1977 book *Fundamental Problems in Phonetics* expresses strong reservations about the setting up of 'universal' phonetic features. Apart from the severe gaps in our knowledge, 'feature-systems tend to lead to the error of procrusteanism - the forcing of data into particular categories just because the categories exist, whether they are appropriate or not' (1977 : 14). In the same book, however, he concedes however that the dimensions along which sound-systems are structured seem to be recurrent and finite. He states for example that 'in descriptive phonetics we seem to have reached a point of diminishing returns : it is only occasionally that some totally new and unknown phonetic phenomenon turns up'. If so, offering theoretical or descriptive schemes which detail the parameters of sound structure cannot be a waste of time. The IPA constitutes such a scheme which is important for two reasons. First of all, the symbols and conventions reflect the insights of classical phonemics and phonetics. While the latter can be criticized in a number of respects, their relevance for descriptive work has never been in much doubt. Secondly, the need for common symbols is paramount if linguistics is a science as claimed (often vociferously) by many of its practicioners. If it is agreed that, assuming a pulmonic egressive airstream, (i) [+consonantal, +continuant, -voice, -anterior, -coronal, +high, -low, +back] (Chomsky and Halle 1968), (ii) [voiceless velar fricative] (IPA) and (iii) [h, @] (Harris 1994) denote the same entity, then there is no reason not to have the same symbol (viz. IPA [x]).

From the early days of his publishing career, Ladefoged was an ardent advocate of the IPA framework. In his 1964[1968] book, *West African Languages : An instrumental-auditory survey*, he states :

'I have tried to keep strictly within the usage prescribed by the International Phonetic Association, whose Principles (1949) are a good guide. I must admit that, like many practising phoneticians, I would like to modify some I.P.A statements quite considerably. Nevertheless I feel there is no justification for setting up a personal set of symbols for the representation of sound that can be adequately handled in the I.P.A. Only when there is no I.P.A. symbol available for the representation of a sound have I felt it legitimate to coin a new symbol or borrow one from some other alphabet' (1968 : xiii).

A stronger defence of the IPA is outlined in his 1990 note 'The revised International Phonetic Alphabet' in *Language*. Following the 1989 Kiel convention in Germany which led to a revision of the IPA chart and paved the way for the 1996 publication of the *Handbook of the International Phonetic Association*, he reminds us that, for linguists, there are three major advantages to the IPA system. First, the IPA has a strong linguistic basis as it is 'intended to be a set of symbols for representing all the possible sounds of the world's languages' (1990a : 551). By 'possible sound' is meant a phonologically contrastive element allowing words to be distinguished from one another. Secondly, the symbols in effect represent distinctive feature

combinations. Even if the term 'feature' is not used, the categories which allow the cross-classification of sounds are intended to be natural classes of sounds. Last, the chart attempts to provide a summary of agreed phonetic knowledge on a single page. While he concedes that there are inadequacies in the IPA system, PL does not see any other reasonable alternative to the use of a common alphabet such as the IPA. An different view is, for instance, adopted in Michael Kenstowicz's reference work *Phonology in Generative Grammar*, the textbook of the 1990s. In it, the author states that, in generative phonology, the American system (as he calls it) has been more commonly employed. As he puts it, 'One reason is that it more closely reflects the idea that sounds are composed of features; it has also the advantage of having fewer symbols to learn and is easier to deploy typographically' (but concedes that with word-processing software this advantage, if it is one, is no longer pertinent). He notes also that linguists have to cope with many systems : 'In general, generative phonologists prefer to retain the transcription of their sources; and so the confusing plethora of symbols is a fact of life that readers of the literature must make the best of' (1994 : 25).

There are problems with Kenstowicz's position. First of all, the American system is clearly variable. Chomsky and Halle's *The Sound Pattern of English* has constituted a de facto standard for many linguists but hardly stopped the multiplication of entities beyond the necessity of scientific communication. Secondly, if one wished to have a notation which reflected the internal make up of sounds then the best notation would be an analphabetic one (like the one put forward by Jespersen (1889) or Pike (1943 : 151-156)). The drawbacks are immediately apparent. As it is, leaving aside suprasegmentals, the IPA includes 31 diacritics (plus apostrophe ' for ejectives in the non-pulmonic consonant box). Finally, is it reasonable to expect readers to cope with all extant and past notational systems to understand work written by linguists? In Kenstowcicz' short introduction to the sounds of speech (ch. 1, pp. 12-46), one comes across three uses of the apostrophe (e.g. [t'] or [k']) : to denote ejectives as in the IPA, palatalization as in Russian, and prevelar articulation (whereas it may be recalled that SPE used [$k_1$] to denote a palatal stop). As Ladefoged trenchantly put it :

'The use of locally approved smbols should become as rare as the reporting of scientific results in other fiels in local units. We would be very surprised if English-speaking chemists called common salt SaCl because their students found Sa an easier abbreviation to remember that Na for sodium. Few of us expect American physics journals to discuss the speed of sound using measurements given in inches per second. Nowadays even the British use calories for measuring heat rather than old-fashioned BTUs (British Thermal Units). Le us hope that similar outdated usages will soon disappear from the linguistic world' (1990a: 552).

The long-awaited publication of the 1996 IPA *Handbook* and the extensive illustration of the IPA notational system in Ladefoged and Maddieson (1996) have contributed in no small way to the scientific unity of our field.

2.3 PL's theory of distinctive features

The theory of distinctive features which was adopted by Ladefoged was close in certain respects to the IPA framework although not fully identical with it. Let us start first of all with his 1971 scheme in *Preliminaries to Linguistic Phonetics*:

| No | Name of feature | Maximum number of systematic phonemic constrasts | Arbitrarily specified terms of use at systematic phonetic level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 0 | Consonantal | 2 | (not applicable at the phonetic level) |
| 1. | Glottal stricture | 3 | glottal stop<br>creak<br>creaky voice<br>tense (stiff) voice<br>voice<br>lax (slack) voice<br>murmur<br>breathy voice<br>voiceless |
| 2. | Voice onset | 3 | voicing throughout articulation<br>voicing during part of the articulation<br>voicing starts immediately after<br>voicing starts shortly after<br>voicing starts considerably later |
| 3. | Fortis-lenis | 2 | normal respiratory activity<br>heightened subglottal pressure |
| 4. | Glottalicness | 3 | ejective (glottis moving air upward)<br>pulmonic<br>implosive (glottis moving air downwards) |
| 5. | Velaric suction | 2 | no click<br>click (ingressive velaric airstream) |
| 6. | Nasality | (2) | oral (velic closure)<br>nasal (velic opening) |
| 7. | Prenasality | 2 | not prenasalized<br>prenasalized |
| 8. | Articulatory place | 6 | bilabial<br>labiodental<br>dental<br>alveolar<br>postalveolar<br>palatal<br>velar<br>uvular<br>pharyngeal<br>glottal<br>labial-velar<br>labial-alveolar |
| 9. | Gravity | 2 | higher pitch spectral energy<br>lower pitch spectral energy |
| 10. | Apicality | 2 | tip of tongue<br>blade of tongue |
| 11. | Stop | 2 | no complete articulatory closure<br>stop closure |
| 12. | Fricative | 2 | no turbulence<br>maximum turbulence |
| 13. | Vibration | 2 | no vibration<br>vibration (trilled) |
| 14. | Rate | (3) | rapid<br>normal |

| | | | |
|---|---|---|---|
| | | | long<br>extra long |
| 15. | Laterality | 2 | central<br>lateral |
| 16. | Sibilance | 2 | no high pitch turbulence<br>high pitch turbulence |
| 17. | Sonorant | 2 | less intensity in the formants<br>greater acoustic energy in the formants |
| 18. | Rounding | 2 | lips spread<br>lips neutral<br>lips closely rounded |
| 19. | Height | 4 | low<br>mid-low<br>mid-high<br>high |
| 20. | Backness | (2) | no tongue retraction<br>body of tongue retracted |
| 21. | Tension | 2 | tongue hollowed<br>no intrinsic tongue contraction<br>tongue bunched |
| 22. | Syllabic | 2 | nonsyllabic<br>syllabic (correlates undefined) |
| 23. | Accent | (2) | not stressed<br>maximal stress pulse |
| 24. | Tone<br>(as in Wang 1967) | | contour<br>high<br>central<br>mid<br>rising<br>falling<br>convex |
| 25. | Cadence | 2 | no intonation change<br>falling intonation |
| 26. | Endglide | 2 | no intonation change<br>final rising intonation |

Without wishing to be exhaustive, some characteristics of this feature system are worth pointing out. First of all, it must be borne in mind that it was devised within the context set by Chomsky and Halle's *Sound Pattern of English*. While rejecting a number of assumptions made by SPE, it retains others. Thus like SPE, the system presented does not impose any hierarchical structure on features. The presentation does distinguish components of speech production (airstream mechanisms, phonation types, supraglottal articulation, etc) but, like SPE, this is not reflected in the notational system. Also, as in SPE, the definition of a phoneme is a matrix of set of simultaneous attribute-value pairs and the system is linear. That is, properties such as prenasalization for example are dealt with as holistic properties and not in the way that have become familiar through multilinear systems. Nor is there much discussion of the possible consequence of the autosegmentalization of features.

But PL's system is unlike SPE in a number of respects. First of all, the system is not binary. PL does agree with Jakobson that 'the binary principle is a major factor in human

communication' (PL 1971 : 91) but he does not draw the conclusion that all distinctive features function in a yes/no mode. He points out that two features, in particular, function in a nonbinary way in nearly all languages: place of articulation and vowel height. He hesitates between two interpretations of place: a multivalued features with each place as an independent item and with a principle of equidistance or as a set of independent binary features (the latter solution being less preferred by PL than the first). Vowel height on the other hand is clearly a multi-valued scalar feature. We have seen earlier that PL favoured an acoustic/auditory description of vowels and F1 is inversely correlated to vowel height: the lower F1 the higher the vowel. The idea of splitting vowel height in two independent features (+/-high, +/-low) always seemed wrong to Ladefoged. As he trenchantly put it:

'I hope that phonologists will soon recognize that we are due for our own little Copernican revolution. It is possible to describe many of the observations of astronomy, and to predict future eclipses while still maintaining that the earth does not move and the sun goes round. But as Galileo (1633) whispered after being forced to retract his Copernican heresy 'Eppur si muove' [still it moves].' Like Galileo, I will not go to the stake for my belief. Still, five vowel systems are most favoured. Mid vowels are between high and low vowels. An interface between phonetics and phonology must allow some phonological features to have non-binary values'. (1992 : 172-173)

Another crucial difference between PL's work and SPE is the need for a dual approach to features : some features are motivated auditorily (e.g. grave/acute), others articulatorily. We have already seen that the treatment of vowels adopted by Ladefoged gave priority to the acoustic/auditory dimension but the point is that this is not the sole example available. The Jakobsonian feature [Grave] which explains the relationship between labials and velars provides another example of the need to bear in mind that language as a communication system is structured around speakers and hearers: the speaker-hearer may well speak to be heard but also hears because s/he can speak. Neither motor factors nor auditory factors are primary, they are both involved in language interaction.

It must be pointed out that PL's theory of DFs is not pure phonetics (whatever that statement might mean). It acknowledges the importance of phonological generalizations. The structure of systems and the rules/constraints which recur across languages give us strong indications as to the building blocks of speech:

'As an example of the facts that demand explanation, consider the types of vowel systems that occur in the world's languages. Maddieson (1984) has shown that over 20% of all languages have vowels somewhat like [i e a o u]. I do not know how many different vowel qualities might have been used contrastively within languages ... As a minimum estimate we can say that there are about 50 broadly distinct vowels that languages might have chosen as the vocalic elements of their segmental inventories. The likelihood of the same five being chosen so frequently is therefore comparable with the likelihood of playing poker and finding that one hand in five always had the Ace, King, Queen, Jack, and Ten of Spades. It is therefore an absolutely astounding fact that so many languages have the vowels /i,e,a,o,u/, and any theory of phonology that does not offer an explanation for this fact must be considered as seriously lacking.' (In Dressler et al. 1992: 167).

The difference between his approach and some other theories of distinctive features is that he was fully committed to understanding the physical underpinnings of features and the role they might play in phonetic events. For PL simply to say that features are cognitive entities (and

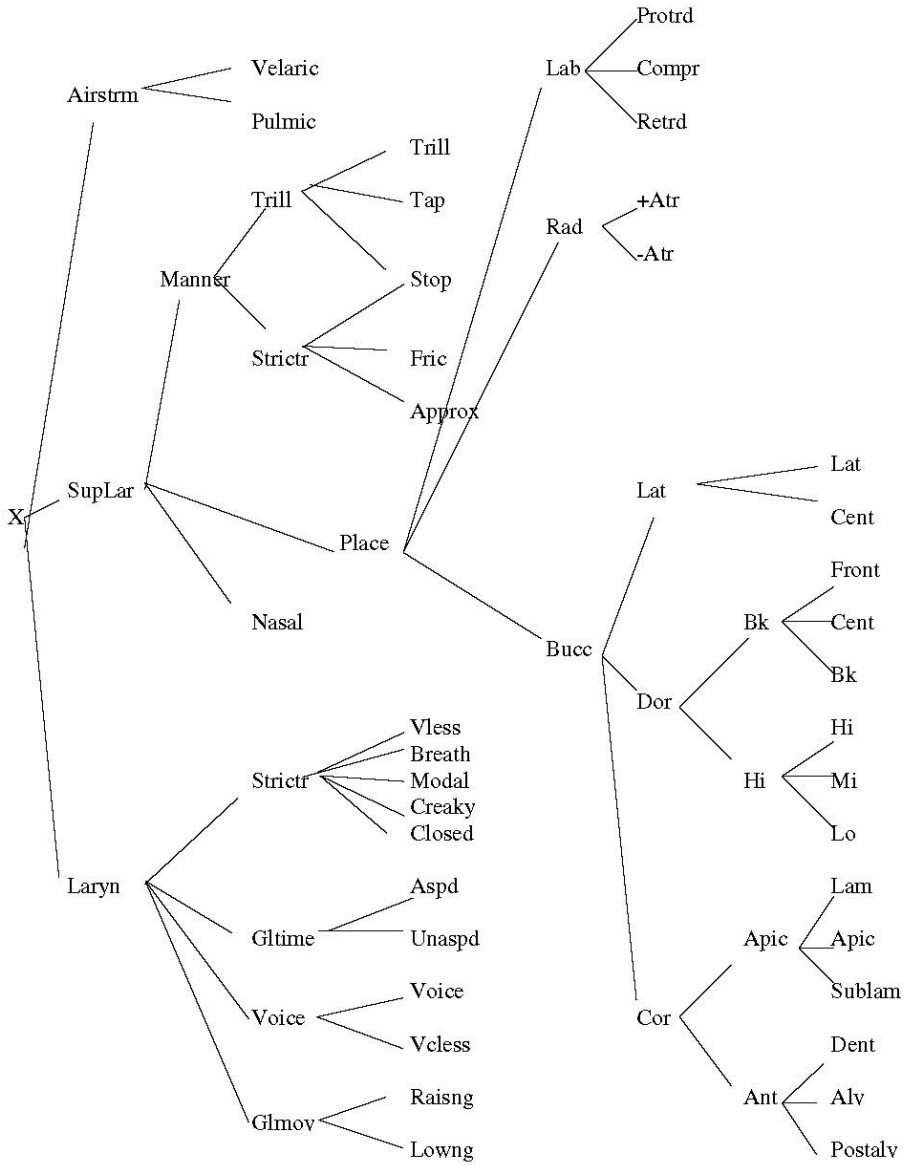
therefore cannot be expected to be found in physical processes) was just a protective belt against any possible invalidation. This is an issue to which we return later.

In more recent years, PL has refined his theory of features. His most detailed presentation is to be found in 'Linguistic Phonetic Descriptions' in Hardcastle and Laver's *The Handbook of Phonetic Sciences* (1996). Other presentations include the coda to Ladefoged and Maddieson (1996), and the brief textbook presentation in the latest edition of *A Course in Phonetics*. Ladefoged (1992) offers the advantage of providing a one page table of his 'hierarchical' approach to features. Our presentation and discussion here will be mainly based on PL's 1996 discussion.

The most striking characteristics of PL's recent views of feature-theory are the adoption of a hierarchical view and further distancing from some aspects of the IPA tradition. A theory of distinctive features, whatever the details, avoids many of the disadvantages of classical phonetics embodied in the IPA format. The latter uses categories which are generally too large. It splits sounds into consonants and vowels and specifies each of them with completely different parameters; but this falls foul of the fact that we don't have two mouths and that cross-classification is the name of the game. Within each of the subcategories, it goes on in the same procrustean mode. For instance, within 'manner of articulation' for 'pulmonic consonants', 'laterals' and 'fricatives' are presented as two separate categories although they are not as proved by the existence of lateral fricatives such as Welsh 'll'. But the IPA system also fails in not explicitly recognizing various feature-groupings which appear to be well supported both phonologically and phonetically. As Ladefoged and Halle (1988: 579-580) put it:

'Finally, the IPA simply lists an ordered set of places and articulation without any internal organization. There are two considerations in which such an organization is evident within the articulations that occur in languages. Firstly, some adjacent places of articulation are more closely related than others. Thus, among the first three items in the list --bilabial, labiodental and dental/alveolar-- there are only a few languages that distinguish between bilabial and labiodental articulations; but there are many that distinguish between labiodental and dental articulations. Secondly, in the description of sounds that have more than one place of articulation, some places can co-occur whereas others cannot. For example, a bilabial articulation co-occurs with a velar articulation in the pronunciation of the Idoma word [àg͡bà] 'jaw'. But it does not make sense to speak of a bilabial articulation co-occurring simultaneously with a labiodental articulation (although, of course, bilabial stops may be followed by labiodental fricatives in affricates)'. (1988 : 579-580).

There are good reasons why a phonetician should think in terms of feature-groupings since phonetic theories have almost always been based on the idea that speech production is based on components larger than features. The British tradition represented by Abercrombie (1967) and Catford (1977), like the American one represented by Pike, adopt the points of view that sound production involves at least major components : Airstream mechanisms, Phonation and (Supralaryngeal) Articulation. Indeed, this is the overall framework adopted by PL a shown in the overall scheme below (courtesy of Gabor Turcsan) which summarizes PL's 1996 synthesis:




Ladefoged accepts this assumption and indeed proposes that segments should be specified as

Space will not allow us to discuss all characteristics of PL's scheme. One of the most salient differences between this framework and PL's previous feature-system(s) is the treatment of 'Place of articulation'. A simplified sub-version of 'Place, which is in fact the starting-point of the 1996 presentation is, as follows:

**Place**

Labial --> {protruded, compressed, retracted}

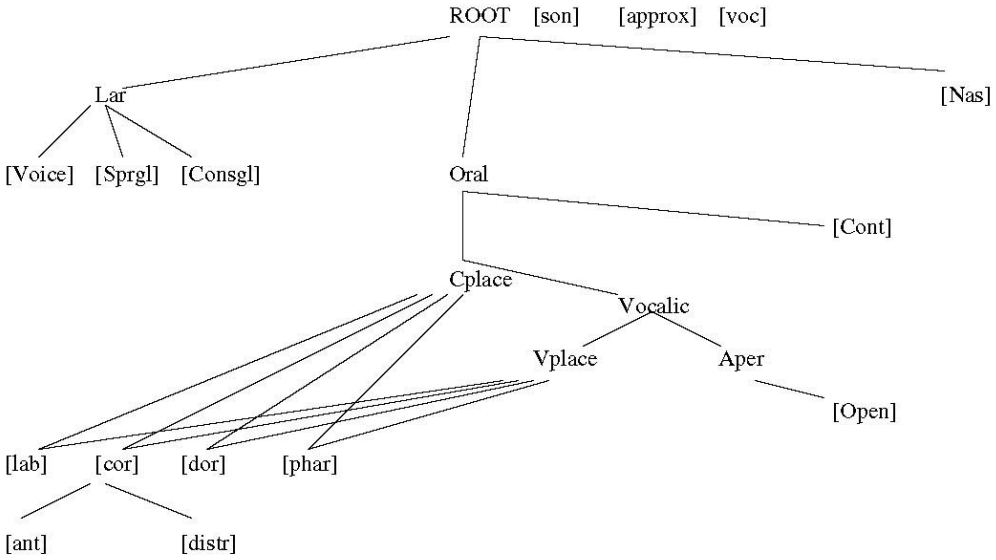
```
              apical  --> {laminal, apical, sublaminal}
           /
Coronal
           \
              anterior --> {dental, alveolar, postalveolar}

          Back --> {front, central, back}
         /
Dorsal
         \
          High --> {high, mid, low}
```

Radical --> {+ATR, -ATR}

In so doing, PL adopts what has been called 'Articulator Theory' (Sagey 1986, Halle 1995, Clements & Hume 1995). Whereas in earlier presentations, PL had stayed quite close to the IPA tradition which treats place of articulation as a continuum from the lips to the glottis, Articulator Theory is based on the division between active and passive articulators: the active articulators are the lips, the blade/tip of the tongue, the dorsum of the tongue, the root of the tongue. At the same time, the widespread adoption of Articulator Theory is a recognition of the fact that strict binarity does not necessarily give the best tool for describing speech sounds and that some of the SPE dichotomies (like +/-anterior in its 1968 definition) have proved less satisfactory than more traditional divisions. Ladefoged and Halle (1988 : 582) describe the move towards Articulatory Theory as a gradual development in their respective positions:

'Halle has been willing to abandon the enforcement of strict binarity on all nodes and allow the Place node to dominate four other nodes (a fact that seems comparatively minor to him, as it is almost evident in his earlier work on redundancy in feature specifications). Ladefoged has abandoned trying to refine 'place' as a set for terms involving both an active and a passive articulator, which should be recognized before more detailed specification of the articulatory region' (1988: 582).

If we compare PL's view with e.g. Clements and Hume's scheme, we can see that there has been an undeniable convergence between linguists working on sound structure.




In a sense, the differences between PL's recent approach and the geometric views inherited from SPE are, on the whole, relatively small and seem to turn around only some features and binarity. One example is [+/-distributed] which seems to PL less clear than traditional labels

like ‘apical’, ‘laminal’ and ‘sublaminal’ (even if potentially +/-distributed has a wider applicability). Another example is the set of features for the Laryngeal node where PL offers a wider choice than standard sets based on spread vs. constricted glottis and tense vs. lax vocal cords. The inclusion of ‘glottal movement’ under the laryngeal node is worth commenting on. One would expect this dimension to be part of airstream mechanisms, if PL was following the traditional treatment of ejectives as ‘glottalic egressive’ sounds and implosives as ‘glottalic ingressive’. In fact, Ladefoged and Maddieson (1996) argue that a close phonetic study of ejectives and implosives does not correspond to this neat picture and that glottal constriction seems to be more relevant than glottal movement as such. If so, the correct treatment of ejectives and injectives might be closer to the minimalist assumption of those who take glottal closure to be the relevant parameter and treat glottal movement as derivative. This is not what the scheme offered by PL says but the location of glottal movement within the set of laryngeal features rather than airstream mechanisms is nevertheless telling.

While there are undeniable convergences, it should also be pointed out that PL’s work does not tie fully with work in the generative tradition. First of all, the set of features is larger than in standard phonological system. Secondly, the features make place for phonetic notions such as ‘airstream mechanism’ or ‘timing gestures’ (eg. VOT, stop/tap/trill) which have no place in alternative accounts. Thirdly, about half of the terminal features put forward by PL are multivalued. Finally, and perhaps most importantly, the features are not neutral between articulation and audition. Six features not included in the above diagram are to be defined primarily in acoustic terms, they are Voice, Grave, Sibilant, Height, Brightness and Sonorant.

An example of an auditorily-based feature is [sonorant] defined as presence or absence of periodic energy with well-defined formants. This feature is “defined in a slightly different way from the definition given by Chomsky and Halle (1968). In many languages sounds such as [m, n, l, r] act together as a class. For instance, in English, these sounds are syllabic after a stop or a fricative, as the ends of the words “table, tassel, sudden, prism, hidden”, but not for most of us after other sonorants such “film, kiln”. The feature Sonorant is hard to define meaningfully in articulatory terms. The notion of “spontaneous voicing”(Chomsky and Halle 1968) does not get at the essence of what it is that causes vowels, nasals, laterals and some approximants to be grouped together. Better articulatory statements can be made in terms of the function of the articulatory system as a whole: sonorant sounds are those in which the vocal cords are vibrating and there is no significant build up of oral pressure. But if we are to claim that the feature Sonorant has this kind of articulatory basis, then we must claim that vocal cord vibrations and lack of pressure are both sensed by a speaker, and then combined so that together they are considered to form a salient psychological percept. This is a rather far-fetched notion for which there is no evidence. The fact that a feature can be defined in a certain way does not necessarily mean that this definition is any help in explaining why the feture groups sounds together into a natural class. Sonorant sounds are clearly related by having a periodic, well-defined, formant structure. They behave the same way within a language not because they are made alike, but because they sound alike.” (1977: 615)

It should be obvious that PL’s position is not simply that we need acoustic and articulatory correlates of features but that, in some cases, no way of meaningfully defining features in terms of one of these dimensions. This should be obvious from the previous quote and from the following statement:

"So far we have been considering only features that specify articulatory distinctions. But phonological features may be based on physiological or acoustic facts. There are several important natural classes that are the results of sounds having an acoustic structure such that they have certain auditory properties in common. It is somewhat ironic that this great insight of the Prague school, which was touted by Jakobson, Fant and Halle (1951), should now be overlooked by phonologists who are their successors. The present situation arises because of the view of phonology propounded by Chomsky and Halle (1968), in which features are considered as mental entities. From this point of view, it is just a matter of exposition as to whether features are defined in articulatory or acoustic terms. But this is simply not true. Segments may occasionally act together because of some abstract mental property, due to the outcome of historic process. But it is much more common for them to be grouped into natural classes because of specific properties relating to the way they are heard, or to the way they are produced. Of course, all features have both articulatory and acoustic properties in the somewhat irrelevant sense that as soon as a feature has been defined in terms of one set of properties, it is possible to infer the other set of properties. Features are linguistic units that (among other things) characterize the lexical items of a language. These lexical items have to be capable of being both spoken and heard; and the features that characterize them must have both kinds of properties. But it does not follow from this that we should consider the linguistic function of a feature as being required in both domains or that we can define it equally well in either way. A similar view has been expressed by Lieberman (1970)." (1997: 611)

PL's position may be correct but it will be seen by many specialists has facing its own difficulties. If we go back to features for vowels, we can see that PL offers two main features: Height and Brightness. Height, we recall, is to be correlated with F1. Brightness is a new feature. It will be remembered that the early work of PL on vowel quality stressed the difficulties of establishing a correlation between backness or roundness as used by phoneticians and formant charts. In the new framework, the feature Brightness corresponds to a mixture of backness / roundness. While the acoustic underpinning of this feature is considered as not fully established by PL, he suggests that we should take it as (F2' - F1), where F2' is a form of the second formant frequency modified as to take into account higher formants (see Bladon and Fant 1978). PL identifies it as Back-Round as defended by Odden (1994) but it might have more appropriately been linked to the prime |U| as used in particle phonology, government phonology or dependency phonology (Anderson and Jones 1974, Anderson and Durand 1986, Anderson and Ewen 1987). The question remains as to the connection between this acoustically based feature and the articulatory dimensions: high-mid-low and front-central-back which are presented in the feature-geometry tree as relevant for consonants and for vowels (and useful for secondary articulations). It is a pity that PL did not explore the consequences of a more radical position which would derive from really treating vowels as auditorily based and consonants as articulatorily based. In the absence of an explicit treatment the alternative position treating features as neutral between production and perception will continue to be adopted by many phonologists.

### 3. Production, perception, cognition and phonological units

Throughout his career, PL was worried about the status of the entities he was postulating as a linguistic phonetician. While he worked with classical concepts such as those of phoneme, allophone, distinctive feature, syllable and the like, there is definitely a strand of scepticism or distancing in his thinking.

To go back to one of his earlier contributions 'Units in the perception and production of speech' (PL 1967 : ch. 3, based on Ladefoged 1959, Broadbent and Ladefoged 1959 and Ladefoged and Broadbent 1960), this is the way he summarizes his findings :

'The final section contains material which has implications for both physiologists and psychologists, as well as linguists and all those who are concerned with describing speech in any way. The production of speech involves some of the most intricate, precisely controlled, muscular movements that a human being can make; and the perception of speech requires a complicated process of pattern recognition. We know very little about the mental processes underlying these activities; but the experiments reported here throw some light on the nature of the stored patterns which must be involved. The data suggest that the smallest units are not likely to be of the size of phonemes. Units such as phonemes may provide a convenient way of describing the competence of a speaker; but they probably have no psychological or physiological correlates in the normal process of listening and talking'. (1967: ch. 3)

It is interesting to note that a similar point of view was shared by PL's teacher David Abercrombie as clearly shown in an article entitled (1965) 'Parameters and phonemes'.[1] In this article, which presents the parametric approach adopted in the early speech synthesis programme PAT (Parametric Artificial Talker) developed in Edinburgh, Abercrombie strongly criticises the 'posture and glide' approach which seems to lie behind phonemic theory and which gives a very biased view of speech production. Abercrombie, while accepting that speaking in terms of phonemes may be useful for certain purposes (like language teaching), says : 'I do not think that the phoneme ... is harmless ; I think it is apt to confuse people's thinking about speech if they are not aware of its fictional nature. I am sure it gives rise, for example, to mistaken ideas about the perception of speech, making people think that phoneme-representing segments are perceived separately and serially - which is most unlikely. But it is not only sometimes misleading ; it is often not the most efficient means for thinking about and describing speech'. (1965 : 122)

Fortunately, PL did not stop at the idea that much linguistic knowledge is stored in a prepackaged way and that linguistic encoding and decoding are far more holistic than usually suspected by linguists. He seems to have accepted that the investigation of units in the speech chain is useful and can give us a handle in the understanding of the nature of linguistic sounds. For instance, in 'Units in the perception and production of speech' (1967), he ventured the hypothesis, requiring a great deal of further investigation, that the most economical model for the process of production might consist of stored target values corresponding to vowels and initial and final consonant allophones. If so, a close study of positional variants of phonemes using the tools of phonetic science can only prove rewarding.

In line with the quotes given so far, PL did not think that standard units such as features could be just assumed to have cognitive (he preferred 'cortical') reality. One of the clearest statements of his position is to be found in 'What are linguistic sounds made of' (1980a), which represents his Presidential Address at the 1978 Annual Meeting of the Linguistic Society of America. As he puts it, 'if we go on using the linguistically well-known feature set which have been found very useful in phonological descriptions, we must do so with the realization that these feature sets -- mine, Chomsky & Halle's, or anyone else's -- have in no way been proved to be the mental representations used by people when speaking or listening to any language. Most of them are completely unnecessary for adequate descriptions of the

[1] Paper first given in 1963 at a conference in Durham, published in *The Child who does not talk*, Clinics in Developmental Medicine, no 13, London, 1964, and reprinted in Abercrombie's *Studies in Phonetics and Linguistics*, 1965, 120-130.

behavior of speakers and listeners. But if they are mental representations, then I would like to know what they are mental representations of. The best answer that I can come up with is that they are part of the mental representations of what a speaker knows about the social institution called language. They are abstract constructs that can be evaluated only in terms of criteria such as the degree of simplicity and elegance that they permit in descriptions of the data'. (1980: 490)

It is not self-evident in what way constructs such as features can be related to language as a social institution. PL points out that we know far more than is required for producing and 0understanding utterances since we can make rhymes, play language games and indeed read and write (with a lot of instruction). Although this issue is not pursued, it may well be that he is attributing our belief in discrete linguistic units to our epi- and meta-linguistic capacities reinforced by writing systems. A contrario, it is always possible to argue that writing systems themselves reflect our intuitive awareness of cognitive units underlying our language activity. Be that as it may, PL has always taken at face value the claim that if features have any reality they must be shown to be relevant for the production and perception of language.

**Conclusion**

In a paper quoted by Peter Ladefoged, his Edinburgh supervisor David Abercrombie said the following concerning the future of phonetics within the wider context of research in linguistics:

'I do not think I would prophesy with confidence about the future of the subject, though I think various things are threatening it at the moment. Nevertheless, I remain optimistic. I heard R.W. Langacker give a very remarkable paper at a conference a few years ago. In it he said that there are two kinds of animals in Linguistics: unicorns and coyotes. Unicorns are noble animals concerned with noble things like the construction of all-embracing theories. Coyotes, on the other hand spend their time grubbing about the mess of linguistic facts. It seems that phoneticians are among the coyotes - indeed Langacker said so. And the last words of his paper were 'the coyotes will inherit the earth'. (Abercrombie 1991 : 11)

We do not know whether Langacker was right. If this dichotomy is accepted, PL probably belonged to the coyotes but he never stopped believing in unicorns and even engaging with them in theory construction. He taught us that if science needs revolutions - which, for linguistics, means adopting a truly experimental approach, relying on numbers and not just logical or algebraic models, strengthening our data bases - we also need to build on the past, to confront points of view and believe in the power of dialogue. Above all, we need to take care of our students, to show them that scientific ideals are not beyond them and to remind them that when they inherit the earth after us they will have the same responsibilities towards their own students.

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