# Speech physics

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*The Physics of Speech.* By D. B. Fry. Pp.148. (Cambridge University Press: Cambridge and New York, 1979.) Hardback £9.50; paperback £3.50.

THE study of speech brings together an extraordinary variety of people. There are not just the phoneticians, old and new, transcribing and measuring, training their ears and improving their syntheses, but also a growing number satellites: computer scientists and electrical engineers intent on recognising and synthesising speech automatically, psychologists trying to understand how on earth we all manage to produce and perceive speech at all, speech pathologists helping those who can't and the theoretical linguists, phonologists and beyond, wondering what it all means.

Students in all these fields need to know the fundamentals of speech, but their teaching presents real problems as the engineer's meat is the pathologist's poison. Professor Fry's book is not for engineers. He manages, successfully, to explain the principles of the physics of speech assuming no mathematical ability in his reader (the only equation used is the definition of the decibel, and Fourier is not even mentioned). Nevertheless, all the necessary ideas are presented in a clear if not very sprightly way. Any student who has read the book carefully will understand the notion of a spectrum, appreciate the distinction between a sound source and its subsequent filtering, know what formants are and how to interpret a spectrogram, and will have some rudimentary knowledge of the acoustic cues to the more important phonetic distinctions. There are, of course, minor flaws, but nothing is seriously misleading.

The competition with which Fry's book has to contend is Ladefoged's *Elements of Acoustic Phonetics*, first published in 1962 and still available in paperback from University of Chicago Press for around two dollars. Ladefoged deals with wave analysis at greater length than Fry, illustrating his chapter with many clear diagrams of waves and spectra. Fry, with some justification, neglects the waveform for the spectrum. I suspect that students will find Ladefoged's treatment of this topic more lively than Fry's, and will appreciate his use of fewer words and more diagrams. But Ladefoged spends appreciably less time on actual speech sounds and their underlying production mechanisms, so that, faced with a real spectrogram, his reader would be considerably more baffled than Fry's. □

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# Variegated manifestations

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*Aspects of Biophysics.* By W. Hughes. Pp.362. (Wiley: New York and Chichester, UK, 1979.) £11.95. *Biophysical Science.* By E. Ackerman, L.B.M. Ellis and L.E. Williams. Second edition. Pp.634. (Prentice-Hall: Englewood Cliffs, New Jersey, and Hemel Hempstead, UK, 1979.) £18.20.

HUGHES quotes a US National Academy of Sciences study which argues that "the classical subdisciplines of biology [that is, zoology, botany, and so on] are insufficiently instructive as approaches to current understanding and appreciation of life in its varigated [*sic*] manifestations". He uses this as a valid justification for cutting through the range of biological phenomena in an orderly way, with the order determined by those physical phenomena which can be discerned among the biological ones. Ackerman and his co-authors find the subject organised in almost the same sequence as that found by Hughes, but they tackle it in the reverse order. The two books are at just about the same level, textbooks suitable for senior undergraduates or junior graduate students.

The problem of teaching biophysics now is akin to the problem of teaching biochemistry about 50 years ago. Then, the question was whether any students would have the requisite background in chemistry and biology: they were likely to have one but not both. Now, the question is whether they have the background of physics, chemistry and biology: they may well have the first two or the last two, but not all three. The two books considered here both affect, in the enthusiasm of their prefaces, to be appropriate to all classes of readers. In a rough way, however, it may be said that Hughes' book is more suited to the student with the physics-chemistry background and Ackerman's to the student with the biology-chemistry background.

Hughes starts with atoms and molecules and with X-ray diffraction and electron microscopy as the techniques of studying the most elementary parts of living things. He builds upwards. He goes on to describe the physics of proteins and nucleic acids, and then membranes and mitochondria, so leading to physical aspects of cellular function and organic function, and finally to still larger problems of living matter. What I particularly liked in his approach is the way he pushes a numerate, mathematical description into quite elementary accounts of the various topics he deals with, from enzyme action to vision. When the topic itself has a well established mathematical formulation, he takes full advantage of it. In his account of nerve action potentials, for example, he gives brief but adequate derivations of cable theory and the Goldman equation for transmembrane potential before going on to obtain the Hodgkin-Huxley equation. However, this is strictly the physics or physical chemistry of the matter — it comes with only the barest introduction and practically no account of the biological consequences. What I found most distressing in Hughes' book were the misprints and spelling errors, starting on line 3 of page ix, as quoted above, and continuing liberally through the text, striking alike at formula and English word.

Ackerman, Ellis and Williams, in the second edition of a book originally by Ackerman alone, have kept to the plan of the first edition. This combines a partly historical approach with some pedagogical insight into what might tempt a student to give attention to topics in biophysics. The Preface proposes Helmholtz as the originator of biophysics and the first chapters deal with Helmholtz' major interests, hearing and vision. The development is then, as it were, analytic in contrast to Hughes' synthetic approach — the electrically sensitive tissues of the body are considered, leading on to other interaction of cells with physical stimuli, to the physical features of cellular function, to the constituent parts of cells, to biological macromolecules, and to the thermodynamics of biological function. In further contrast to Hughes, Ackerman and his colleagues seem to pull in mathematical explanation with some reluctance when it can hardly be avoided, but prefer a descriptive approach. In their account of nerve action, they give a brief explanation of the Hodgkin-Huxley equation but do not mention cable theory or even the Nernst or Goldman formulae for transmembrane potential. In most other cases, however, they end up by giving much the same physics in much the same mathematical form as is given by Hughes, but accompany it with fuller verbal explanation and better indications of the implications for the study of biology. Ackerman and his co-authors devote the final part of their book, a sixth of the whole text, to biophysical techniques and instrumentation and to medical applications of biophysics. That this section, seventeen years later, is the only one which required major recasting from the first edition, shows how well Ackerman judged his original text; and the second edition preserves the confidence and balance of the first.

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