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ERIC J. HELLER, *Why you hear what you hear: An experiential approach to sound, music, and psychoacoustics*. Princeton, NJ & Oxford: Princeton University Press, 2012. Pp. i–xxviii + 590. ISBN: 9780691148595
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Even if I were capable of attempting one, *JIPA* would not be the place for a comprehensive review of this huge, exuberant book of which the six sections and 28 chapters range over sound propagation, wave phenomenology, Fourier analysis, autocorrelation, sound sources, horns, sirens, strings, damped and driven oscillators, Helmholtz resonators, turbulence, musical instruments, the voice, the hearing mechanism, pitch perception, architectural acoustics, and long-range sound propagation in the atmosphere. The focus must rather be on what the book has to say about speech, and the value of the book for teachers and researchers in phonetics.

One will search in vain for Heller's name in the annals of acoustic or auditory research. He is by trade a quantum physicist and theoretical chemist, and the book arose from his teaching (with others) of a course on 'The physics of music and sound' for non-specialists within the 'General education' component of Harvard's degree programme. The teaching was evidently designed and delivered with enthusiasm and creativity, and students no doubt found the course inspiring. But as a result of its origins this book is to some extent the work of a physicist on vacation, and determined to enjoy himself.

It is far too big to be a coursebook. It is more like an encyclopaedic resource for a whole range of courses. It weighs almost 2 kg, is beautifully printed and bound, and has nearly 400 colour illustrations (Heller is an artist and photographer too). A website (http://www.whyyouhearwhatyouhear.com/), maintained by the author, rather than the publisher, has extensive supplements to each chapter, links to numerous online resources, and a 110-page 'problem book'. The book launched with a flotilla of endorsements already in

place ('delightful … richly illustrated', 'massive … sweeping … immense … singular and unique', 'impressive … fantastic'), including one from Nobel Laureate David Politzer, who describes it as 'truly a treasure'. It quickly attracted favourable reviews in *Contemporary Physics* and elsewhere (Rossing 2013, Vogel 2013, Russell 2014).

At the same time, however, it is an unusual and idiosyncratic book. There are hardly any in-text references. The bibliography for the whole work runs to just 30 items, and their average date of publication is 1980. What Heller finds interesting in what has 'evolved in the last twenty years' (p. xix) is not, it seems, the most recent auditory research, but the availability of free software such as Audacity and Praat, and simulations with Java and Mathematica applets or MAX 'patches' so that now 'anyone with a laptop has a fully portable sound laboratory and recording studio'. Of course, this is true to an extent (though it doesn't turn 'anyone with a laptop' into a cutting-edge researcher), and Heller is also right to point out in the very first sentence of the Preface that '[n]o book about vision and visual art is devoid of diagrams and reproductions, yet books about sound and music are traditionally mute'. But it is also true that any book or course which relies on a particular range of software tools or web resources is vulnerable to rapid obsolescence. In the short time since this book's publication, Java applets have fallen into disfavour with modern browsers, and to make Java work for some of the simulations in the book you now have to resurrect a legacy browser (or install an emulator).

The treatment of speech (Chapter 17, pp. 352–373) is actually titled 'Voice' (though it contains almost nothing on the larynx or the acoustic voice source), and is rather oddly placed within the section of the book dealing with musical instruments – it's sandwiched between wind instruments and the violin. Since the book is supposedly not designed to be read strictly consecutively, you're meant to be able to start with whatever interests you, and backtrack or follow cross-references as necessary. But the author's claim 'If singing, phonetics and voice are a special interest, it is possible to start in chapter 17' (p. xxiv) won't stand scrutiny. The chapter opens with a challenging thought-experiment about the effect of constrictions on standing-wave resonances in tubes, which – if you can follow it – leads to an intuitive grasp of something resembling perturbation theory. But anyone who was REALLY starting from scratch would be in trouble within half-a-dozen lines, and forced to go looking for earlier sections of the book dealing with the relevant background, a process not made easier by the fact that the crucial terms 'node' and 'antinode' are missing from the index (at hardly more than seven pages, the index seems seriously undersized for a work on this scale). The treatment of formants and vowels which follows can only be described as chaotic. The first quantity the author attempts to determine, and encourages the reader to determine for his/her own vocal tract, is Q (Q isn't in the index either). You're meant to do this by analysing the spectrum of your own whispered vowel 'ohhh . . . ' (whatever that is). But nowhere in the chapter (or the website, or the problem book) is it suggested what software to use for this. Perhaps the enterprising reader is meant to figure out that Audacity can be used. This is followed by an abrupt and impenetrable digression on why 'the source-filter idea is technically wrong'. Not until the closing lines of the section is it indicated (and it's never really explicitly stated) that different vowels are characterised by different formant configurations. There is no kind of F1/F2 plot, and not even a table of formant frequencies for a set of vowels. Meanwhile the reader is encouraged to use the recommended apps *Vowels*, *Partials* and *Formants* to experiment and learn by trial and error. But these apps are so flexible and unconstrained that one could tinker endlessly producing interesting sounds and images while learning effectively nothing. The author then embarks on a hurried succession of entertaining irrelevancies: the 'singer's formant', Tuvan overtone signing, the speaking trumpet (megaphone), multiphonic clarinet playing, effects of helium and SF6 on formant frequencies, and the *vox humana* organ pipe. A short paragraph is headed 'Fricatives and other sounds', but neither fricatives nor any other sound types are actually defined or exemplified. The paragraph ends with: 'Without going into further detail, we are confident that we have the principles in place to make sense of any sound that can be produced'. In other words, once you know something about the acoustics of vowels, the rest is too trivial to bother with.

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Overall, the defects identified in the disappointing speech chapter are characteristic of the book as a whole. There are brilliant explanations, original ideas, exciting demonstrations – but a lack of basic background, clear definitions of terms, or a reasonably balanced introduction to established work in the field.

I have certainly enjoyed reading this book, and learned a great deal, but sadly, despite its numerous attractions, this is not the book on acoustics and hearing that phoneticians need, and especially not the one their students need. It is a work to go into the library, but to be kept off the essential reading list. The beginning student is better served by Plack (2014) – mundane, monochrome and 'mute' though that may be by comparison.

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