significant proportion of plants have some form of inbreeding, usually self-fertilization, and expected inbreeding coefficients above 0.9 are not unusual. By contrast, the extensive surveys compiled here report only two vertebrate populations, of splendid fairy-wrens and great tits, that have matings suggesting inbreeding coefficients above 0.05. (For comparison, 25% full-sib mating and 75% random mating every generation result in an inbreeding coefficient of only 0.077 at equilibrium.) Further, a follow-up study of the wren nestlings showed, according to Rowley, Russell, and Brooker, that "more than 60% of the nestlings examined could not have been sired by any male in the social group that raised them." In other words, inbreeding rates based on observed pairings may be grossly inaccurate because of extrapair copulation or other phenomena. In invertebrates, particularly arachnids, there may be species that have higher inbreeding levels, but the documentation is relatively poor (surprisingly, there are no references in the book to the elegant work on selfing in slugs and snails by Selander).

I think one of the most important implications of the low level of inbreeding found in most vertebrate populations is that it might very well result in a high genetic load. If populations of such species radically decline in numbers or are brought into a captive situation where there is inbreeding, the expectation is that inbreeding depression would be a severe problem. Although not all captive endangered animals show inbreeding depression for juvenile survival, the component of fitness easiest to document, it is generally recognized as a severe problem in maintaining many endangered species.

One of the major topics of discussion in the book is the theory that there is an optimal level of inbreeding, two of whose chief proponents, Shields and Waser, played a central role in the original symposium. Most people, though I have found not all, will agree that the offspring of closely related individuals generally have lower fitness than those resulting from random matings. Further, it generally appears that crosses between distantly related individuals (from different species?) also generally have lower fitness. There may thus be an optimum level of inbreeding between these two extremes at which fitness is higher, but that it is on the same spatial scale as dispersal in most species seems unlikely. The middle ground may be very wide, with little fitness differential and therefore insignificant potential for selective change. Overall, there is virtually no evidence given here for outbreeding depression in animals that favors its existence on the scale at which even maximum dispersal might occur. For plants, Waser provides a table of examples divided into sections based on whether the best performance is from the longest-distance outcross, the shortest-distance outcross, or an intermediate outcross. As he states in summarizing this survey, "Empirical evidence is mixed at best. . . . Even those studies listed in the table as demonstrating isolation by distance usually show patterns in poor quantitative agreement with theoretical predictions."

As we broaden our knowledge of inbreeding and outbreeding in various species, it seems the subject becomes more complicated and fewer generalities are possible. Or, as Hamilton puts it in conclusion, "It seems that notwithstanding all the facts and theories in this book (including mine), we hardly begin to know answers to any of these questions."

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Auditory Cognition

Thinking in Sound. The Cognitive Psychology of Human Audition. STEPHEN McADAMS and EMMANUEL BIGAND, Eds. Oxford University Press, New York, 1993. xiv, 354 pp., illus. $67.50 or £45; paper, $26.95 or £17.50.

The definition of cognition adopted by the editors of this book is one that would be familiar to most cognitive psychologists: " 'Cognition' refers to the notion of knowledge. It has been used in a more specific sense to designate the conditions that allow humans to develop knowledge of the world." Clearly, sound is one pathway to knowledge of our environment. Yet cognitive science has long been dominated by studies focusing on visual input. When sound has been studied in the context of cognition, it has generally been limited to speech. With *Thinking in Sound: The Cognitive Psychology of Human Audition* McAdams and Bigand suggest that the time has come to formulate an auditory view of cognition that is general enough to encompass any auditory signal.

Overall there is not much that is new in this book, with one important exception—the material on sound source determination, or auditory scene analysis. The auditory system does not directly transduce the source of sound. (In this way it differs from other sensory systems, such as the visual system or the skin.) Rather, the auditory periphery provides a time-frequency code of the acoustic sound field that arrives at the two ears from all of the sound sources that surround us. It is through higher-order mechanisms that process the time-frequency code that the auditory system segregates the sensory information into units that allow for the determination of the original sound sources, which is a fundamental perceptual ability. It seems clear that the ability to make use of the information gained about the auditory scene demands attentional, memorial, and informational processing. That is, cognition plays a major role in auditory scene analysis in any realistic acoustic environment. Many theorists also argue that cognitive processes play a role in forming or modulating the perceptual ability to determine the sources of sound. Sound source determination has only recently been recognized as an important element of auditory cognition in all acoustic settings. *Thinking in Sound* combines work on sound source determination and knowledge in the more traditional areas of auditory processing to form the beginnings of a unified view of auditory cognition.

Most of the book follows a traditional "bottom-up" path to cognitive processing, starting with perception and ending with recognition. Bregman describes his view of auditory perception in a synopsis of his recent book *Auditory Scene Analysis* (MIT Press, 1990), outlining some postulates of perceptual regularities that govern the temporal (sequential) and spectral (simultaneous) organization of sensory information required for auditory perception. Warren continues the discussion of auditory perception, concentrating on temporal organization. Jones and Yee address theories of selective and divided attention to scenes of auditory events. Auditory memory is discussed by Crowder, and theoretical and empirical work on sound source recognition is described by McAdams. The remaining three chapters deal with auditory cognition in three special situations. Peretz describes many clinical cases of auditory agnosia—the inability to comprehend auditory input—and the insights into cognition that they have provided. The study of music has spawned many theories of auditory perception, and much of this work is reviewed by Bigand. In the final chapter, Trehub and Trainor describe the development of auditory processing of complex (especially nonspeech) sounds in infants and children.

Almost every contributor to this book wrestles with basic terminology, revealing that the field of auditory cognition is still in its infancy. The glossary at the end of the book is helpful in this regard, but it does not contain terms such as "object," "event," "entity," or "image," all of which are used (by different authors) to refer to the perceptual units on the basis of which the sources of sound are determined. Uni-

formity in the terminology of the field has suffered from a long-standing lack of consensus as to whether or not sound can be considered to have the attributes of an object.

Although cognitive, hearing, and speech scientists all have an interest in the topic of auditory cognition, this book will probably appeal most to cognitive psychologists. For full appreciation of all the material, it is helpful to have a reasonably good command of music notation and theory. However, even those without musical experience will find this a useful book for broadening their view of human cognition.

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Vignettes: Mentoring

I tried to teach Fermi to fish, and it seemed to me he liked it. However, he once returned [to Los Alamos] from Chicago with a lake fishing rod and reel. I told him that it was not suitable for mountain streams, but to no avail. Fermi developed a theory on how trout should bite and on how to catch them. The theory was disproved by experiment, but this did not impress him in the least. Ultimately he abandoned fishing, but not his theory.

—*Emilio Segrè*, in *A Mind Always in Motion: The Autobiography of Emilio Segrè* (University of California Press)

I will never forget the time when a distinguished European physicist, en route to exploring academic positions in the United States, visited the Ewalds; after dinner he was taken aside by Paul, and admonished in all seriousness that the first thing he would have to learn as a professor in the United States is to help in washing the dishes. And so they both disappeared in the kitchen.

—*Hellmut J. Juretschke*, in *P. P. Ewald and His Dynamical Theory of X-Ray Diffraction: A Memorial Volume* (D. W. J. Cruickshank, H. J. Juretschke, and N. Kato, Eds.; Oxford University Press)

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