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MAKING SENSE OF THE WORLD

A review of *Sensory Ecology, Behaviour and Evolution* by Martin Stevens. Oxford University Press (2013), 264 pages. ISBN: 978-0-199-60178-3

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Different organisms have access to different and differing amounts of information about the world. Species occupy different perceptual worlds and human psychophysics and neuroscience have given us an extensive understanding of our own. Similarly, several researchers in animal behaviour have long been interested in the question of how other animals sense the world and how this affects their interactions and their evolution: the fundamental questions of sensory ecology. While there are now regular workshops, courses and reviews dedicated to sensory ecology, it is still often referred to as an emerging field. In fact, sensory ecology has been emerging for a while; DUSENBERRY'S classic book on the field (DUSENBERRY 1992) was written more than twenty years ago. The intervening decades have seen much fascinating research that has vastly expanded the scope and depth of the field. The new book, *Sensory Ecology, Behaviour and Evolution* by Martin Stevens is therefore a welcome and important introduction to this body of research and is perhaps a sign of the field truly coming into its own.

Given the broad scope of sensory ecology, it could and often does encompass several aspects of neurobiology, evolutionary biology and even physics. It is no surprise then that Stevens deals with a wide canvas – the book begins with physiology and sensory processing and takes us on a journey through to evolutionary arms races and species divergence via chapters on communication and mimicry. Thus, rather than each chapter being devoted to a specific sensory modality (e.g. Chapter One: Vision; Chapter 3: Olfaction), the chapters are centred on specific themes – such as information encoding or trade-offs and costs in signalling. This helps highlight both the commonalities and differences between modalities and the book doesn't shy away from pointing these out. It also often points out connections across the different chapters, thus sometimes foreshadowing evolutionary theories while discussing sensory trade-offs or reminding the reader of descriptions of sensory systems while elaborating the evolutionary consequences. This has the admirable effect of giving readers a broad perspective of the field, enabling them to see

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both proximate and ultimate aspects of behaviour simultaneously. It also keeps the book fizzing with ideas and concepts – over the course of two pages it can touch upon, for example, polarization vision, search images, the genetics of primate vision and bat-insect arms races. While this is a thrilling ride, it can sometimes make the reading slow going despite the clarity of the writing – as one pauses to wrap one's head around each new concept.

The wealth of examples and illustrations, however, provide ample help, giving the reader a quick and easy grasp of the theory. Stevens deploys examples to good use; almost every principle or theory is accompanied by several short examples. In addition, certain examples are pursued in depth for particularly well studied systems: the tungara frog is used as an example of how predation pressure can shape signal evolution; arms races are illustrated using brood parasitism by cuckoos; an extended discussion on wolf spider mate choice is used to clarify multimodal communication. This often provides the reader with an invaluable review of contemporary research on topics as well as structuring the research around more theoretical discussions about sensory processing, signalling, communication and evolution. The book uses these examples to present us with a complex picture of each phenomenon, discussing all the different factors that might be involved. In the introductory chapter on communication, for example, rather than rely on a simple caricature of signaller, receiver and environment, the discussion also includes predators and eavesdroppers.

This attempt to capture the breadth and complexity of sensory phenomena is also reflected in the variety of modalities covered in the books. Despite apologies in the introduction for any potential bias towards vision and audition, the examples are often chosen from a wide range of sensory modalities. So while researchers on visual crypsis, for example, might find the book particularly helpful, research on non-human sensory modalities such as vibratory cues, electroreception and magnetoreception is by no means neglected. Specific examples of behaviour – electric signalling in fish or visual camouflage, say – are often elaborated upon across different chapters. This provides us with a complete picture of the sensory ecology of particular behaviours. The flipside is that it also can lead to a cursory description of others. This sometimes reflects the degree of research on each area or system, but this is not always the case. Despite the charismatic fennec fox on the cover, for example, there are perhaps fewer examples drawn from mammals with little reference to mammalian pheromonal communication and almost no discussion of acoustic communication in marine mammals or deer. Researchers on insect visual navigation might also feel a touch underrepresented given the bulk of research in the field. Still, books, like sensory systems, have trade-offs and while not everybody's favourite system or behaviour might have equal representation, the book serves well as a great introduction and will definitely have new stories for everyone regardless of their research expertise. The only major criticism is that the book gives the reader the misleading impression – emphasized in the concluding remarks – that studies of sound (other than on barn owls and bats) have largely ignored the sensory systems

of receivers. Sound perception in both insects and frogs is well studied and includes research on the neurophysiology and biomechanics of sound reception (GERHARDT and HUBER 2002), receiver psychology (POLLACK 2000; MILLER and BEE 2012) and pioneering studies on the neurophysiology of sound perception in the field (ROEMER 1998; PFEIFFER et al. 2012). The inclusion of this body of research in future editions will surely enhance the wider appeal of the book.

Perhaps the greatest strength of the book lies in its vision of sensory ecology as synthesis, bringing together fields that span the entire scope of biology: from molecular genetics to neuroscience to macroevolution. Using this integrative approach gives the book large dividends because it squarely places the sensory mechanisms discussed in the early chapters in the context of the evolutionary and environmental forces discussed in the later chapters, thus providing the reader with a genuinely holistic view of different behaviours. It also helps with a valiant and largely successful attempt at providing a common framework and clarifying terminology with which to analyse them. Behaviour and signals are throughout evaluated for those aspects or constraints that involve strategy (related to information) and those that involve efficacy (related to transmission). Clear definitions are provided that differentiate between cues, signals and components and multimodal and multicomponent signals. Later in the book, the boundaries between sensory drive, sensory exploitation and sensory traps are also clearly demarcated despite the considerable overlap in the way these are discussed in the literature.

With its focus on contemporary research and in-depth coverage of several modalities and fields, this book will be an indispensable aid to anyone teaching behaviour, communication or sensory biology. The book is well produced with ample colour figures and illustrations that help the reader appreciate and fully comprehend the text. The helpful addition of definitions, summaries and suggestions for future research also add to its attraction as a reference book. Another useful tool is the use of special boxes that explain key phenomena – such as neural transmission or models of speciation – without breaking the flow of the text. Personally, I hope for several future editions at regular intervals to keep informed about and captivated by the wealth of excellent research constantly emerging in the field.

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