# LEARNING AND ADAPTATION

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A review of

COGNITIVE ECOLOGY: THE EVOLUTIONARY ECOLOGY OF INFORMATION PROCESSING AND DECISION MAKING.

*Edited by Reuven Dukas. Chicago (Illinois): University of Chicago Press.* $95.00 (hardcover); $30.00 (paper). ix + 420 p; ill.; index. ISBN: 0-226-16932-4 (hc); 0-226-16933-2 (pb). 1998.

E L Thorndike (1874–1949) was remarkable in two respects: first, he was one of the founders of modern experimental psychology and the study of animal learning. Second, he was the first behavioral scientist since the publication of *The Origin of Species* to completely ignore Darwin and his ideas.

Ever since Thorndike, psychology and evolutionary ecology have taken separate paths. In the introductory chapter of his new book, Dukas hits the nail on the head by saying that those paths ought to intersect. We cannot understand how and why brains function without knowing how they evolved; we cannot understand how animals interact with their environments without understanding their mechanisms of information processing. Dukas brought together a group of excellent scientists whose recent work has been poised at the boundary between these two divergent disciplines, and who are likely to provide important stimuli in the newly budding field of cognitive ecology.

Enquist and Arak criticize the classic ethological view that the evolution of communication systems will lead to mutually and optimally tuned signals and receivers. Using artificial neural networks, they point out that biases may be a general property of perceptual systems, and these may represent a strong force in driving the evolution of the many striking biological signals we see. Although the models are convincing, an emphasis on how sensory mechanisms really function would be helpful. There is a vast literature on the little tricks and simple solutions sensory-perceptual systems use to cope with complex problems, and they rarely provide a perfect picture of the real world: almost invariably they involve biases and distortions.

The chapter on constraints on information processing (by Dukas) reviews theoretical considerations and evidence from human subjects to show that there might be limitations in attending to several tasks simultaneously and efficiently. The psychology literature, however, also shows that for many pairs of tasks, there are no such tradeoffs, and thus we must demonstrate them empirically. But Dukas is asking extremely important questions such as: are there costs to maintaining long-term memory? Are working memory limitations relevant for foraging? Are there difficulties in remaining vigilant for predators for extended periods of time? Will cognitive constraints favor specialization when prey is cryptic?

In his chapter on the evolutionary ecology of learning, Dukas reveals how much we still have to learn. We are now certain that learning, at least in simple forms, is a phenomenon shared by all animals, and that they learn about surprisingly diverse aspects of their lives. It is intuitively appealing to assume that this learning is related to their fitness, but we do not yet understand how learning mechanisms evolve, let alone how they adapt to the particular environmental needs of each species. This is because we need more phylogenetic studies, more data on interindividual variance within species, biogeographical studies, and fitness tests related to learning. Without such studies, all considerations of learning adaptations will remain "just-so stories."

Beecher et al. describe the fascinating ways in which young sparrows acquire songs, how they decide which songs to acquire, how they combine elements copied from songs of others to form their own individual repertoire, and how these songs are used to communicate with territorial neighbors. They present convincing arguments that the study of song learning must take into account an animal's socioecological context, and therefore field studies are essential.

In the chapter, Cognitive Ecology of Navigation, Dyer first maps out the diversity of problems faced by animals in search of familiar goals. Animal orientation is a mature field, but the neuroethologists and physiologists who studied it were largely inter-

ested in the mechanisms, and not so much in the question of how spatial memory is involved in real-life ecological problems such as foraging. In his chapter, Sherry elaborates on the many situations in which spatial memory is needed, and then moves on to discuss the neuronal mechanisms that have been implicated in memorizing space. The correlation of hippocampus size and food storing is one of the few adaptive stories on memory that are convincing from an evolutionary point of view, because it takes into account phylogenetic data.

In one of the book's best chapters, Bateson and Kacelnik review both mechanistic and adaptive explanations of why animals are often sensitive to variation in the quality of food sources. Both perspectives provide theoretical reasons for why animals might sometimes be risk-prone and sometimes risk-averse. The authors argue convincingly that we need a merger between the mechanistic and the functional perspectives if we are to resolve the questions about risk-sensitive foraging.

Ydenberg's chapter on foraging theory elaborates on the currencies, strategies and constraints that play a role when animals acquire food and information, and avoid predators. His chapter also illustrates how far we are from linking foraging theory with a mechanistic (or cognitive) perspective. Foraging models that illuminate how animals process information, by integrating the literature on sensory mechanisms, as well as those of learning and memory, still need to be developed.

In the chapter, Evolutionary Ecology of Partner Choice, Dugatkin and Sih show that in addition to choosing mates, animals have good reasons to care about others they spend their time with. Clearly, such decisions may involve cognitive components: how are the characteristics of partners assessed, perceived, memorized, categorized, transferred, and generalized? We know virtually nothing about these problems; the cognitive issues involved in partner choice are interesting and worth further exploration.

Cognitive ecology is firmly rooted in behavioral ecology, and thus it is probably not surprising that the beginning of this science (including several chapters of this book) is still somewhat remote from the animals' physiology. Clearly, this connection will be strengthened in the very near future. It would have been useful to have a chapter on sensory ecology—after all, sense organs are the interfaces between the outside (ecological) world and cognition, and we have good mechanistic knowledge on how they function. It would also have been interesting to mention that attempts to link ecology with neuroethology have also been undertaken from the other (neuroethological) side. For example, R Menzel, who invested decades in deciphering the mechanisms of bee memory storage and retrieval, has recently studied how these memories are used in natural foraging conditions. But these lacunae in the book are forgivable, given that relinking Thorndike's science with that of Darwin is a fairly novel idea.

Overall, I found this to be a very stimulating book. The chapters are well written and intelligible, and the paperback comes at a very affordable price.