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Book Reviews

The Organization of Learning, By CHARLES R. GALLISTEL. Cambridge, Massachusetts: MIT Press (1990). Pp. viii + 648. Price £40-50.

The title of this book is slightly misleading—it is primarily about the problem of how animal nervous systems encode information about space, time and number. There is for instance nothing here about imprinting or song-learning in birds, and nothing on human learning. On the other hand, it provides a wide-ranging and thorough review of a number of topics in animal behaviour not often brought into contact. As well as migration and navigation in birds, the organization of spatial information by honey bees, and maze learning in rats, there is estimation of egocentric distance and angle in sand scorpions, locusts, toads, chameleons and gerbils, and puddle-jumping by gobies. And as well as circadian rhythms in running-wheel activity by rats and mice we have the re-visiting strategies of hummingbirds and scheduled breast-feeding by hares. The writing and the illustrations are exceptionally clear and elegant, and thus the book should be valuable to many readers merely as a literature review.

But Gallistel did not write it for this purpose—the data are here to be explained, and new explanations are liberally given. Individual explanations are mathematical in form, and there is a sustained argument for a 'computational-representational' approach to the theory of animal behaviour. Flow diagrams and equations are produced which could solve behavioural problems, and the claim made that a sufficiently elegant and effective computation model is likely to mirror what nervous systems do, down to the level of individual neurons. In most cases the models remain hypothetical. 'Gallistel is particularly taken with methods of dead-reckoning, which he believes are ubiquitous in all mobile species, from the desert ant to people. Flow diagrams are given for the necessary calculations of distances travelled in directions assessed by sun-compass calculations, using both Cartesian and polar co-ordinates. On computational grounds the version using polar co-ordinates should be more error prone, and Gallistel suggests that natural selection must necessarily therefore favour the Cartesian model, although the fallibility of dead-reckoning in practice, at least in humans in strange cities, suggests that this may not apply universally across species.

Dead-reckoning also comes up in the context of the analysis of neural mechanisms of learning. A surprising feature of the book is that Gallistel is firmly against the notion that nervous systems encode information via synaptic changes, both in its traditional associationist and behaviourist form, and in the current vogue of neural network simulations. Since he assumes that mechanisms for dead-reckoning calculations must be universal, he recommends that neuroscientists should ignore synaptic changes and start looking instead for an intracellular protein whose metabolism has properties that map onto the values of a dead-reckoning integral. I doubt if many will take him up on this, but it is a thought-provoking line of argument, and a salutary reminder that theories of behavioural function ought at some stage to be related to theories of behavioural and neural mechanisms—and vice versa. In addition to possible methods of dealing with spatial information, Gallistel examines mechanisms for encoding time and number, supposing that the rate at which events occur would be detected most economically by systems that divide number by time, and argues that representations of rate of occurrence (and of statistical uncertainties associated with rate estimates) are responsible for the behavioural regularities observed both in natural foraging and in laboratory tests of learning and conditioning.

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Insect Defences. Adaptive Mechanisms and Strategies of Prey and Predators. Edited by DAVID L. EVANS & JUSTIN O. SCHMIDT. Albany, New York: State University of New York Press (1990). Pp. xv + 482. Price $73-50 hardback, $24-95 paperback.

Fifteen diverse and thought-provoking essays are gathered together under four headings: evolution of major defensive ensembles; predatory strategies and tactics; predation prevention: avoidance and escape behaviours; and predation prevention: chemical and behavioural counterattack. The authors were specifically invited to write the essays:

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