

the neuroanatomical circuitry involved in language processing. One striking example of the re-definition of anatomical structures comes from work on Broca's area that is discussed in the book. Even though Broca's area was discovered and described by Paul Broca more than a century ago, and even though its function has been firmly linked with speech production in a large body of literature since then, careful anatomical research now shows that Broca's area may require a new and more refined anatomical definition. This type of research is crucial to fMRI studies that have identified activations in putative 'Broca's area', and

illustrates the more general point that solid conclusions about the relationship between brain and behavior require careful definitions of neuroanatomy.

A final very interesting issue that is addressed in this book concerns the neural connectivity for language processing. In the end, knowing which areas 'light up' when humans are engaged in language processing does not tell us very much about the relative contribution of each of these areas to the language processes involved. Here, the authors discuss ways in which to formalize models that will allow us to use the fMRI technique to enlighten us about the brain

circuitry of language. In conclusion, the *Neurocognition of Language* is an important and captivating book, one that has been long awaited by all researchers interested in language and the brain.

Tamara Swaab

Duke University, Center for Cognitive Neuroscience and Department of Psychology: Experimental Room B203, LSRC Bldg., Box 90999, Durham, NC 27708-0999, USA.
tel: +1 919 681 0660
fax: +1 919 681 0815
e-mail: swaab@duke.edu

Cognition, Evolution, and Behavior

by Sara J. Shettleworth, Oxford University Press, 1998. \$45.00 (xii + 688 pages)
ISBN 0 19 511048 X

Anthropomorphic accounts of animal behaviour rarely stand up to rigorous scrutiny, but one theoretical concept that originated in discussions of human cognition translates surprisingly well into Sara Shettleworth's long review of information processing capacities in animals. This is Fodor's 'modularity' thesis – that animal information processing is accomplished by a wide variety of modules that are domain specific, encapsulated, and so on.

A stated aim of this book is to argue for an adaptationist approach to cognition. The way in which modularity suits the adaptationist approach is especially obvious when it is applied to sensory mechanisms that are unfamiliar to us, although readily understandable as ecologically appropriate – such as echolocation in bats, detection of objects via electrostatic fields in fish living in turbid waters, or the use of sky-polarization compasses for homing in diurnal insects and vertebrates. These examples, among others, are the starting point of Shettleworth's treatment of perception and attention, which sets the stage for subsequent chapters covering topics such as memory and discrimination learning.

However, an equally important theme of the book is the inherent interdisciplinarity of questions that arise from the attempt to understand how animals are able to deploy their specialized sensory adaptations, and whether such information processing in animals bears any relation to the study of human cognition. Shettleworth has a joint appointment in departments of psychology and zoology, and her book integrates well material that would otherwise be covered separately in psychology texts (e.g. experimental studies of laboratory animals performing artificial tasks) and zoology texts (e.g. studies of the evolution, development and function of the natural behaviour patterns of a

wide range of species, under the general heading of 'behavioral ecology'). Shettleworth's book attempts to synthesize these two approaches to animal behaviour by explicitly endorsing the concept of evolved adaptations and organizing the material according to psychological categories, such as 'simple recognition learning' (which encompasses habituation, perceptual learning and social imprinting) and also ecological categories, such as 'foraging and measuring rate'.

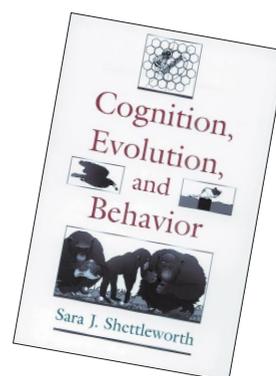
Zoologists, such as Tinbergen, have analyzed animal behaviour in terms of hierarchically organized fixed input-output relationships, or instincts. The reason why the term 'cognition', which implies a richer kind of information processing, applies to such behaviour, and why Shettleworth also reviews the findings from the very different tradition of behaviourist or associative theories of animal learning can be illustrated by the standard uses to which some of the more unfamiliar sensory capacities are put. Most animals are mobile and many need a high degree of sensitivity to their environment. This applies particularly to central place foragers, such as bees and ants, and also the animals (rats and pigeons) most commonly used by experimental psychologists. This means that no matter how fixed and innate the geographical sensing modules are, they are used to monitor local and transient information – animals need to *learn* about the location of their own nest or hive, their own current position, and the changing location of food sources.

It is therefore no coincidence that information processing was introduced into animal psychology by E.C. Tolman's use of the term 'cognitive map'. However, the current consensus seems to be that this is a misnomer, because (at least for social insects and rats) the representation of space is predominantly in terms

of self-motion, and observed behaviours can be explained by the dynamic combination of path-integration vectors, 'snap-shot' views of visual landmarks, and memorized routes. In view of the computational load imposed by path-integration ('dead-reckoning') and the flexibility with which different sources of geographical information are typically utilized, spatial orientation is no less interesting. Shettleworth concludes that asking the question 'does this animal have a cognitive map?' is less useful than asking 'how does this animal represent space?'

Research deriving some impetus from human cognitive phenomena (e.g. studies of cache recovery in food-hoarding birds) are termed 'anthropocentric' by Shettleworth. She reserves the term 'anthropomorphic' for unjustified imputing of human-like cognitive attributes to other species. This applies to a large fraction of research on imitative learning in animals, as well as to attempts to hold conversations with chimpanzees. Not only do chimpanzees not engage in small talk, but they also appear to be unable to notice any difference in the likelihood of attracting the attention of a human experimenter wearing a dark scarf over her eyes as opposed to her mouth. Such evidence bolsters the case for humans having many cognitive modules that are not shared with other species, even chimpanzees, and perhaps even suggests that the set of cognitive modules available to any particular species is unique.

Even so, many of the behavioural phenomena described here are ex-



tremely widespread. Shettleworth says that data on time-interval judgements are 'suggestive of pretty wide phylogenetic generality among vertebrates' (p. 355), and examples of Weber's Law, habituation, and anticipatory response shifts along the lines of Pavlovian conditioning can be found in just about every species studied, from *Caenorhabditis elegans* (which has only 302 neurons) to the chimpanzee, which, although lacking human cognitive modules, appears to have a brain that is remarkably like our own, if one third the size. Shettleworth generously concludes that behavioural ecologists interested in 'optimal foraging theory' would have had to have invented the Skinner box if Skinner hadn't done so first. There thus remains scope for general theories concerning the biological origin and neural mechanisms of what Davey¹ has called 'global adaptations', as well as continuing behavioural explorations of the natural history of cognitive diversity.

Previous attempts to resolve the tension between evidence for some forms of species-general learning mechanisms

and the undoubted primacy in animal behaviour of what Shettleworth calls 'evolved predispositions' include the books by Gallistel², which is frequently cited, and Davey¹. Shettleworth's book is encyclopaedic in scope, measured in its opinions and written in a more accessible style than either of its predecessors. Its range, up-to-date content and reasoned advocacy should be widely welcomed. Zoologists and psychologists alike would learn much about each other's literatures by reading it.

In summing up, Shettleworth returns to the theme of modularity. She undoubtedly succeeds in demonstrating the variety of adaptively specialized cognitive modules that are available for study in the natural world. Moreover, it is arguable that animal cognition is, if anything, even more modular than human information processing³, but that does not preclude, especially in the vertebrate brain, rich interactions between modules and a wealth of possible permutations of module taxonomy. It is likely that in the near future an interdisciplinary account of animal cognition

will need to incorporate findings from both neuroscience and molecular genetics, and although these disciplines are only occasionally alluded to here, practitioners of them will find this a useful compendium of behaviours they may wish to study. Nevertheless, the primary audience for the book remains the students on courses in comparative cognition to whom it is dedicated.

Stephen F. Walker

Department of Psychology,
Birkbeck College, University of London,
Malet Street, London,
UK WC1E 7HX.
tel: +44 0207 631 6590
fax: +44 0207 631 6206
e-mail: s.walker@bbk.ac.uk

References

- 1 Davey, G. (1989) *Ecological Learning Theory*, Routledge
- 2 Gallistel, C.R. (1990) *The Organization of Learning*, MIT Press
- 3 Coltheart, M. (1999) Modularity and cognition *Trends Cognit. Sci.* 3, 115–120

Books Received

Review copies of the following books have been received. Books that have been reviewed in *Trends in Cognitive Sciences* are not included.

The appearance of a book in the list does not preclude the possibility of it being reviewed in the future.

E. Basar *Brain Function and Oscillations I: Brain Oscillations. Principles and Approaches* Springer-Verlag 1998 £57.00 ISBN 3 540 64338 9

E-E. Baulieu, P. Robel and M. Schumacher (eds) *Neurosteroids: a new regulatory function in the nervous system Humana Press* 1999 \$135 ISBN 0 896 03545 X

Benedicte de Boysson-Bardies *How Language Comes to Children: From Birth to Two Years* The MIT Press 1999 \$27.50 ISBN 0 262 02453 5

R.A. Brooks *Cambrian Intelligence: The Early History of the New AI* The MIT Press 1999 \$25.00 ISBN 0 262 52263 2

N. Burgess, K.J. Jeffery and J. O'Keefe (eds) *The Hippocampal and Parietal Foundations of Spatial Cognition* Oxford University Press 1998 £60.00 ISBN 0 19 852453 6

R. Casati and A.C. Varzi *Parts and Places: The Structures of Spatial Representation* The MIT Press 1999 \$35.00 ISBN 0 262 203266 X

F. Fabbro (eds) *Concise Encyclopedia of Language Pathology* Pergamon (Elsevier Science) 1999 \$148.00 ISBN 0 08 043151 8

P.W. Halligan and A.S. David (eds) *Conversion Hysteria: Towards a Cognitive Neuropsychological Account* Psychology Press 1999 ISBN 0 863 77651 5

G. Hinton and T.J. Sejnowski (eds) *Unsupervised Learning: Foundations of Neural Computation* The MIT Press 1999 \$30.00 ISBN 0 262 58168 X

P.S. Katz (eds) *Beyond Neurotransmission: Neuromodulation and its Importance for Information Processing* Oxford University Press 1999 £45.00 ISBN 0 19 852424 2

B. Libet, A. Freeman and K. Sutherland (eds) *The Volitional Brain: Towards a Neuroscience of Free Will* Imprint Academic 1999 £19.95 ISBN 0 907 84550 9

W.G. Lycan (ed.) *Mind and Cognition: An Anthology* Blackwell 1999 £60.00/\$64.95 (hbk) £17.99/\$34.95 (pbk) ISBN 0 631 21204 3 (hbk) / 0 631 20545 4 (pbk)

M.E. Maurish (eds) *The Use of Psychological Testing For Treatment Planning and Outcomes Assessment* Lawrence Erlbaum 1999 \$250.00 ISBN 0 805 82761 7

E. Margolis and S. Laurence (eds) *Concepts: Core Readings* The MIT Press 1999 £48.95 ISBN 0 262 63193 8

D. McKnight *People, Countries and the Rainbow Serpent: Systems of Classification among the Lardil of Mornington Island* Oxford University Press 1999 £50.00 ISBN 0 195 09621 5

A. Miyake and P. Shah (eds) *Models of Working Memory: Mechanisms of Active Maintenance and Executive Control* CUP 1999 £47.50 ISBN 0 521 58721

D.A. Norman *The Invisible Computer* The MIT Press 1999 \$13.95 ISBN 0 262 14065 9

D.A. Rosenbaum and C.E. Collyer (eds) *Timing of Behaviour: Neural: Psychological and Computational Perspectives* The MIT Press 1998 £33.95 ISBN 0 262 18188 6

R.D. Traub, J.G.R. Jefferys and M.A. Whittington (eds) *Fast Oscillations in Cortical Circuits* The MIT Press 1999 £34.95 ISBN 0 262 20118 6

F.J. Varela *Ethical Know-How: Action, Wisdom and Cognition* Stanford University Press 1999 £7.95 ISBN 0 804 73033 4

F. Varela and J. Shear (eds) *The View from Within: First-person Approaches to the Study of Consciousness* Imprint Academic 1999 £27.00 ISBN 0 907845 30 4

V. Walsh and J. Kulikowski (eds) *Perceptual Constancy: Why Things Look as They Do* Cambridge University Press 1998 £45.00/\$69.95 ISBN 0 521 46061 1

R.A. Wilson and F.C. Keil (eds) *The MIT Encyclopedia of the Cognitive Sciences* The MIT Press 1999 \$145.00 ISBN 0 262 23200 6