Reviews

Brain, perception, memory: Advances in cognitive neuroscience edited by J J Bolhuis; Oxford University Press, Oxford, 2000, 371 pages, £60.00 cloth; £27.50 paper (US $105.00, $50.00) ISBN 0 19 852483 8, 0 19 852482 X

Brain, Perception, Memory: Advances in Cognitive Neuroscience is intended to be a comprehensive textbook with up to date reviews of research within the field of cognitive neuroscience, and is dedicated to the work of Gabriel Horn. It certainly achieves both aims, since the collection of essays it presents covers many levels of brain activity. In three sections covering perceptual and attentional mechanisms, cellular and molecular aspects of learning and memory, and finally systems underlying learning and memory, contributors report research from both animal and human populations. The breadth and depth that this approach gives are tremendous. I learnt something from every chapter and am sure that I will refer back to this book in future. Having had no formal physiology training in my psychology background, the work of Horn was new to me and it, along with much of the other work in this book, is highly relevant to my own research.

Of particular interest to me in the first section were the several approaches to the question of how information is integrated within the brain. The first two chapters deal with the integration and separation of input from different modalities. Graziano, Wheeler, and Gross (pages 7–15) present research which outlines the modulation of receptive-field properties of pre-motor cortex to visual, auditory, tactile, and mnemonic attention, thus allowing the guidance of head and limb movement. Stein, Wallace, Stanford, and McHaffie (pages 17–34) outline the role of the superior colliculus in integrating multi-sensory information.

In the third chapter, Singer (pages 35–48) outlines the necessity for and existence of the coordination of cellular output to within a few milliseconds in the visual and sub-millisecond range in auditory systems. This speed is critical, since perceptual grouping has to be quicker than actual perception as higher level processing necessarily involves such evaluation. Singer suggests therefore that there are two separate coding mechanisms, the first is the explicit representation of features and conjunctions, which occur frequently or are of behavioural relevance, and the second is the implicit representation of features and conjunctions of infrequent or novel information. This latter mechanism may be signalled by the precise synchronisation of cellular output from neurons within assemblies processing the constituent features of an object. In human electrophysiology increased power in the beta (20–30 Hz) and gamma (30–70 Hz) EEG is found during perception and attention tasks (Brown 2000, 2001; Müller 2000; Tallon-Baudry and Bertrand 1999). On a broader scale of analysis, Duncan (pages 49–68) outlines the network properties of attention; suggesting that there is no localised system undertaking visual attention, instead objects are attended to as the many brain systems involved converge to work on the multiple properties of the object. The final chapter in the first section deals with mechanisms of plasticity [Johnson and Bolhuis (pages 69–84)] and presents fascinating evidence that ‘innate’ predispositions are the result of interaction between the individual and its environment.

In the second section, the level of analysis is the molecular and cellular structure of learning and memory. The wide range of evidence presented in this section attempts to answer the question “what sort of chemical and physical changes occur during learning, and whereabouts in the brain are they located?” Brennan and Keverne (pages 93–112) present evidence from across species (rat and sheep) that in olfactory learning, neurotransmitter increases lead to increased synaptic density. They further review evidence that synchronised high-frequency cellular activity is part of the learning and recall mechanism. Clayton (pages 113–125) shows that the integration of vocal motor control, auditory representation, and sensorimotor feedback in bird-song within both environment and genetic constraints, offers a testable model of brain function at all levels of investigation from molecular through to ethological.

Smulders and DeVoogd (pages 127–148) and later Winder and Kandel (pages 163–184), and Brown (pages 185–208) discuss the hippocampal contributions to learning of spatial memory, a new genetic approach to studying long-term potentiation of cells within the hippocampus, and
the neural contributions of the perirhinal cortex in recognition memory, respectively. Dudai and Morris (pages 149–162) concentrate on the cellular (as opposed to system) level of consolidation of memories. They present evidence that consolidation is a dynamic process, occurring at different levels of resolution, perceptual binding occurring at the sub-millisecond range by fast coincidence detection (chapter 3), context binding on a scale of minutes to hours utilising cellular changes, and the binding of events into narratives and categories over weeks or years when system consolidation occurs.

In the third section the systems underlying memory and learning are analysed, which necessarily involves investigation of brain areas as functional units and/or components of functional networks. Chapters include contributions regarding the role of the cerebellum in motor learning [King and Thompson (pages 215–231)], the role of amygdala in emotion-related context of memory formation [McGaugh, Cahil, Ferry, and Roozendaal (pages 234–251)] and as the locus of fear conditioning [Nader and LeDoux (pages 254–266)]. The roles of the hippocampus and perirhinal cortex are discussed with respect to both memory and perception [Buckley and Gaffan (pages 279–298)] in the monkey, and Dolan (pages 299–310) reports human fMRI evidence of separate neural systems for associative priming and perceptual priming. Bateson (pages 266–278), using models of imprinting, gives an overview of systems level analysis, and Weiskrantz (pages 311–325) presents the seemingly paradoxical evidence from human and animal lesion studies that there are several systems involved in perception, memory, and awareness.

It was interesting to note the disagreement regarding the function of the amygdala between McGaugh et al and Nader and LeDoux. The former posit the modulatory role of the amygdala in memory formation elsewhere, mediated by hormonal release, whereas the latter explicitly postulate that the amygdala is the site of fear-conditioned learning. This is not a failing of the book, which is an honest reflection of the ongoing debate within neuroscience, which accepts that the complexity of nervous systems must necessarily involve complexity in arrangement and function.

In terms of usefulness to psychologists, the final chapter of this section by Weiskrantz and the final chapter of the book by Horn (pages 329–363) are probably of greatest value. Weiskrantz’s thoughtful and wide-ranging review of neuropsychological phenomena such as blindsight and numbsense or performance without awareness, would be of value to all psychology undergraduates. The final chapter of the book which covers the physiological, from the chemical through cellular to localisation, basis of learning from habituation through imprinting is likely to be of great use to psychology students at all levels with an interest in the biological basis of behaviour.

This is true of the rest of this book, and indeed would be of interest to post-doctoral readers too. As mentioned above, my personal training in physiology was lacking, but this book has helped me to consolidate a great deal of my own research and pointed me towards new vistas. The approach of many of the authors is forward-looking and exciting, and I have no hesitation in recommending it. Its cost is quite reasonable, especially since the paperback copy is sold at less than £30 ($50), bringing it within the reach of students.

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