Nerve Cells and Animal Behaviour

Extensively revised, the third edition of this introduction to neuroethology – the neuronal basis of animal behaviour – is written for zoology, biology and psychology students. It focuses on the roles of individual nerve cells in behaviour, from simple startle responses to complex behaviours, such as route learning by rats and singing by crickets and by birds. The text begins by examining the relationship between brains and behaviour and shows how study of specialised behaviours reveals neuronal mechanisms that control behaviour. Information processing by nerve cells is introduced using specific examples, and how the roles of neurons in behaviour are established is described for a predator–prey interaction, toads versus cockroaches. Much new material is included in chapters: on vision by insects, which describes sensory filtering; hunting by owls and bats, which describes sensory maps; and on rhythmical movements including swimming and flying.

Peter Simmons regularly publishes research on insect neurobiology, especially on the ocellar and compound eye visual systems and their role in controlling flight, and on the physiology of synaptic transmission. He is currently Director of the Zoology Degree at Newcastle University.

David Young has undertaken research and teaching on the link between neurobiology and behaviour in insects, looking at both sensory and motor systems. A special interest has been the mechanisms of sound production in crickets and cicadas. He is also the author of *The Discovery of Evolution* (2007) published by the Natural History Museum/Cambridge University Press.

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Third edition

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Preface

Our aim in this book is to introduce university students to research on nervous systems that is directly relevant to animal behaviour, and to do so without assuming a detailed knowledge of neurophysiology. We concentrate on examples of studies in neuroethology that illustrate clearly how the activity of nerve cells is linked with animal behaviour. The level of the book is for advanced undergraduate students, particularly those studying zoology, biology or psychology, but we hope it will also be useful to students in other disciplines and to postgraduates.

Each chapter is given a title in two parts: a description of its general area and then usually the specific topics to be described. We begin with a consideration of how animal behaviour and brains are organised. Chapter 2 is an introduction to the nuts and bolts of how nerve cells work, and we approach this by referring to specific examples that illustrate concepts without delving into detailed cellular physiology. The next two chapters describe some clear examples where the roles of particular neurons in predator–prey interactions have been established. We then describe two different types of sensory systems in which roles of specific neurons in behaviour have been recognised – vision in insects and hearing in owls and bats – followed by a chapter on the control of rhythmical movements. Chapter 8 describes research on changes in behaviour, including learning. The final chapter describes signalling behaviours, and shows how the ways that nerve cells are involved in relatively complex behaviours can be studied.

At the end of each chapter are features designed to help students consolidate and extend their knowledge. The purpose of the questions is to stimulate thought and discussion: they are not meant to be the kinds of questions that have definite right or wrong answers. Further reading often provides avenues for further explanation of the topics covered in the chapter, as well as useful reviews. Partly in response to demand from students, each chapter ends with a summary – but we hope these summaries will not discourage students from making their own notes as they read. Many new terms are set in **bold** type the first time they appear in the book in order to help a reader to come to grips with unfamiliar terms and concepts, and the page on which each term is first described are also indicated in bold in the index.

In this third edition we have made some significant changes to content and arrangement. All of the chapters include new material, and some are almost completely new, and some of the figures from the previous editions have been modified. Some topics, such as singing by crickets, that were omitted from the second edition are now

included again with new research stories. Questions and summaries for each chapter are new. Also new are photographs which introduce some topics and should help to bring some of the behaviours we describe to life.

Neuroethology is an active area of research, and there are many interesting topics we cannot cover within the limits of our book. Some, such as animal navigation, are outside the scope of a book on nerve cells and behaviour. Others, of which learning by *Aplysia* is a prime example, are covered well by other neurobiology or general behaviour texts. Inevitably, some of the topics covered by the book – bird song is a likely one – will come to be in need of updating fairly soon. But it is striking that a number of sections in the first edition, written by David Young over 20 years ago, still provide solid foundations in this subject. Some people argue that textbooks are now out of date, superseded by web-based provision of learning material. We would not have embarked on writing a new edition of this book if we agreed with that. There are advantages in a coherent approach offered by one or two authors in a book, and although there are some excellent websites in neuroethology, coverage as a whole is extremely patchy.

Much of the revision was by Peter Simmons, and he is grateful to many people for helpful comments and for encouragement. These include a number of undergraduate and postgraduate students, and members of the Newcastle University Centre for Evolution and Behaviour. Colleagues he would like to thank include Claire Rind, Alan Roberts and Natalie Hempel de Ibarra, as well as others who have been very generous in providing photographs for us to use.