

## Multimodal computation in neural networks

<b>Reference</b>	BB/F006780/1
<b>Principal Investigator / Supervisor</b>	Professor Philip Newland
<b>Co-Investigators / Co-Supervisors</b>	Professor Robert Allen, Dr David Simpson
<b>Institution</b>	University of Southampton
<b>Department</b>	School of Biological Sciences
<b>Funding Type</b>	Research
<b>Value (£)</b>	530,982
<b>Status</b>	Current
<b>Type</b>	Research Grant
<b>Start Date</b>	31 July 2008
<b>End Date</b>	01 March 2012
<b>Duration</b>	43 months

### Abstract

Insects, just like humans, are able to make remarkably precise movements of their limbs, but they are able to do it even though the numbers of neurones present within their central nervous systems are many orders of magnitude less than in mammals. This project aims to understand how this control is achieved and how the relatively small numbers of neurones in the insect central nervous system achieve the high degree of versatility of movement and similar precision of higher animals. Much of the precision and versatility in control is thought to reside in the different types of interneurons present within the neural networks that generate and control limb movement, their modes of communication, by both digital (action potential or 'spikes') and analogue signals (synaptic potentials), and the way in which they perform multiple simultaneous computations. We aim to systematically analyse the response properties of the interneurons using advanced signal processing techniques and relate their morphological features to their integrative properties. In addition we will analyse how the nervous system performs the integrative task of processing multiple sensory parameters and ask if specialist neurones or populations of neurones process different signals (high frequency versus low frequency inputs, or velocity versus position or acceleration), what the benefits of digital signalling compared to analogue signalling are, and what the different branches of a neurone contribute to integration compared to the whole cell (using laser ablation). Understanding how the insect nervous system solves the problem of controlling precise movements will ultimately have many benefits, including a better understanding of how the nervous systems perform complex control tasks, generate new hypotheses on how the brains of more complex vertebrates solve similar tasks, and will provide the basis for biologically inspired engineering solutions to movement control.

### Summary

We can make remarkably precise movements of our limbs but how the movements are produced and controlled by our brains is less clearly understood. Insects can also make precise movements of their limbs even though the numbers of nerve cells in their brains are many times smaller. This project aims to improve our understanding of how the nervous system of an insect, the desert locust, is able to generate and control these limb movements by asking what the roles of the different types of nerve cell, or interneurons, are when movements of a leg are made, and how intersegmental coordination and additional multimodal inputs change the responses of the interneurons. This will be done by using mathematical models to quantify an interneuron's response to an imposed limb movement. These models will be constructed for many different cells and their contributions to the final limb movement determined. It is also thought that different parts of a nerve cell can simultaneously perform different functions, although this has not been studied in any detail. Using a combination of physiological recording combined with imaging techniques the aim of the project is to establish what this form of distributed processing contributes to the control of movements. Engineers have spent many years developing new ways of controlling robot movements and we believe that it may be possible that the way insects control and produce their limb movements could, in the future, form the basis of an improved design for controlling robotic appendages, biomechanics and movement analysis.

<b>Committee</b>	Closed Committee - Animal Sciences (AS)
<b>Research Topics</b>	Bioinformatics and E-Science, Neuroscience and Behaviour (including human psychology)
<b>Research Priority</b>	X – not assigned to a current Research Priority
<b>Research Initiative</b>	X - not in an Initiative
<b>Funding Scheme</b>	X – not Funded via a specific Funding Scheme