Title of lecture misplaced NWB 18/11/2011

27 May 2002

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Academic Autobiography

I was a student at Clare College from 1967-1970 and read Zoology. For my PhD I went to the Department of Neurobiology, Australian National University, Canberra to work with Adrian Horridge on neural circuits and behaviour in insects. To my surprise (it had all seemed much too difficult when I was an undergrad) I ended up working on compound eyes and vision. For my thesis I look at signal processing in dragonfly compound eyes and discovered how neural circuits adjust the compound eye to the wide range of light-levels encountered in everyday life. Luckily, I had the excitement of collaborating with mathematicians and physicists. Together we saw aspects of design that none of us would have realised alone (e.g. the function of optical waveguides, using information theory to understand how eyes optimally encode pictures). I left Canberra in 1984 for a lectureship in Zoology in Cambridge. Here, guided by the preparation of lectures, I have incorporated the biophysics of neural mechanisms into my understanding of neural circuit design. As befits a zoologist, I have also developed a comparative approach to understanding the structure, function, design and evolution of visual systems. At the moment I am the Rank Research Professor in Opto-electronics.

Synopsis of Talk

Understanding the working of brains is a major intellectual and technical challenge. Insect compound eyes offer the opportunity to take a rigorous approach to understanding how neural circuits process information to generate behaviour. The opportunity has been created by three experimental advantages; accurate descriptions of the neural circuits behind the eye, recordings of the electrical signals in intact circuits and quantitative analyses of visually guided behaviour. These descriptions are then tied together with theories from physics, engineering and computer science to understand how neural circuits are designed to process information efficiently. The results that we see in insect eyes illuminate a number of general problems. How does a visual system adjust to light level so that we can see as well as possible? How does one build a reliable brain using wildly inaccurate components? Why does the human brain use so much energy, does this usage influence the design of our brain, and has energy usage constrained the brain’s evolution?