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Foreword

The brain is an intriguing system, combining analog and discrete computation. It is adaptive at a millisecond time scale, but also accumulates experience over years. Its computational elements are individual living cells that locally attempt to optimise their living conditions, using mechanisms of the domain of molecular biology, chemistry and physics, yet at a large scale, a coherent ensemble emerges producing abstract thoughts, behaviour and communication via language. Neural coding refers to the encoding and decoding of signals in the nervous system, the exact nature of which is still a great puzzle for science.

The Fourth Biennial Neural Coding Workshop (NCWS'2001) was held at the University of Plymouth (UK)[1] during the week of September 9–14, 2001. The previous meetings of this series were held in Osaka 1999, Versailles 1997, and Prague 1995. The workshops foster cross-disciplinary approaches to the study of the neural code.

Over the years, neural coding has emerged as a complex and multifaceted problem:

1) There is no single code. The code varies along and across sensory information-processing streams. It is also different for various elements in local microcircuits and it may vary with tasks.
2) This variety reflects a number of constraints including energy consumption, speed of processing, commonality of representation in areas of convergence, and the need for divergent top-down control.
3) Experimental data are sparsely sampled on various levels of our understanding. Modelling shies away from bridging these levels or misses whole fields of experiments.

Progress in understanding the neural code requires a progressive integration of multilevel constraints in models and corresponding new experimental data. Therefore, the aim for this workshop was to further an integrated approach to neural coding.

NCWS workshops traditionally concentrate on understanding processes at the neuronal level. The 2001 workshop attempted to address the wider question of how these processes reflect functional constraints that underlie the effective operation of biological systems. Some more specific questions put to the participants were: How is a neuronal code specific to a given sensory system? How is a code transformed from sensors to higher brain areas? How does the code depend on the current information-processing task? How is the neural code affected by learning? Some of these were discussed in details, but many are still open.

A wide range of specialists (75) participated in the Plymouth Workshop, including experts in the visual, auditory and olfactory systems, researchers in neuromorphic hardware, prosthesis and neural implants, and those modelling at all levels, from behaviour and learning to the influence of noise on the function of single cells. Abstracts of the presentations can be found in the workshop Web site: http://www.tech.plym.ac.uk/ncws2001.

A selection of the presentations was submitted to this special issue, reflecting the latest results presented at the workshop.

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Plymouth was a particularly significant place to hold this conference considering the seminal work by Alan L. Hodgkin and Andrew F. Huxley. From 1938, A.L. Hodgkin visited each year the Marine Biological Association's Laboratory at Plymouth to characterise the membrane properties of the giant axon of the squid. This work culminated in 1952 with the publication of a series of fundamental papers describing the mechanisms of spike generation. This led to their 1963 Nobel Prize. Fifty years later, the Hodgkin–Huxley equation still plays a fundamental role in neural coding, as can be seen in many papers of this special issue.

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