C.	Catherine	Carr
----	-----------	------

Department of Zoology, University of Maryland, USA

Preface

Catherine Carr, Department of Zoology, University of Maryland, College Park, Maryland 20742–4415, USA

In 1991, the Karger Workshop at the annual meeting of the J.B. Johnston Club was entitled 'Effectors, Behavior and Evolution'. The adaptive interactions of an animal with its environment require control systems that incorporate both motor circuitry and effector organs. Since neural and effector systems find their origins in previously existing systems that have been modified to serve new functions, how these systems are modified during the evolution of new behaviors is a fundamental question in biology. In this workshop, the J.B. Johnston Club hoped that the examination of many different effector and control systems would shed insight into their organization and evolution. Workshop speakers were asked to emphasize their particular experimental approaches and to stress the questions that most need to be answered.

The Karger guest speaker, C. Gans, spoke on functional morphology and biomechanics. He made several points designed to disturb and enlighten neurobiologists. In an evolutionary vein, he provided examples of muscles that may have evolved for purposes other than their present day functions. Furthermore, he stressed that the understanding of muscle system structure requires analysis not only of the adult functions of these muscles but also their development. From the point of view of motor control, Gans pointed out that, regrettably, muscle control does not simply relate to any simple parameter. It is necessary to know what forces and excursions the muscles exert, and how muscles are composed, before evaluating their interactions with neural control systems.

J. Fetcho used examples from lampreys and anamniotes to infer the motor apparatus of early vertebrates and to discuss the evolution of spinal motor networks. The question arises as to whether there are multiple adaptive control mechanisms, which differ significantly among vertebrate species, or whether there are common strategies, which are simply more elaborated in animals with more highly developed behavioral repertoires. Fetcho noted that even amniotes retain some aspects of primitive motor patterns, even though there are substantial differences in the neural control systems, muscles, and behavior.

To generate behavior, the brain must transform sensory information into signals that are appropriate to control movement, and T. Masino described his work on both barn owls and frogs in a discussion of these transformations in the neural code for head movement. He described experiments that delineate the fundamental differences between sensory and motor coordinate frames, and went on to discuss how intermediate representations may be used to direct complex movements.

The issue of motor control systems was continued in a presentation by A. Cohen on the role of heterarchical control in the evolution of central pattern generators. She discussed both biomechanical and evolutionary pressures on control of locomotion and made a strong statement in support of the concept of heterarchical, as opposed to hierarchical, control systems. Evidence was presented that the interfaces between the descending and sensory inputs and the central pattern generators allow for distributed and adaptive control systems.

K. Nishikawa presented specific examples of feeding behavior in frogs in a discussion of the evolution of neural circuits that control this behavior. She has used a phylogenetic approach to identify behavioral transitions among feeding strategies during evolution. Once identified, the neural basis of these transitions may be examined. Remarkably, some aspects of motor control circuits, such

Not all effector systems involve striated muscles; L. Demski compared the neural control of color change in fish and cephalopods. The two systems display striking parallels in their levels of organization. They differ from the other effector systems in that they are both driven by external forces, i.e. predators, rather than by sensory feedback.

T. The analyses of the evolution of motor control systems presented in this symposium have illuminated a complex and important field of neuroscience. The presentations were distinguished by their comparative approach to the problems of effectors systems

level of motor control and evolution of behavior. These issues are central to the field of motor control and