Introduction

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Over the past 20 years neuroethological studies of auditory and electrosensory systems have been increasing in number. Supported by roots in ethology, investigations in these areas include studies of signal characteristics, their production and control, and their processing by the nervous system. Today, work in these two areas represents some of the most sophisticated work on the sensory basis of complex vertebrate behavior.

The recent emphasis on these two systems represents a departure from the classical studies of the early ethologists which were concerned almost exclusively with visual communication signals. Lorenz, Tinbergen and their students typically focused on displays with brightly colored or highly contrasting visual sign stimuli such as the bright red belly of the courting male stickleback. The early ethologists were concerned with identifying key features of these stimuli and determining, at least theoretically, how the nervous system encodes them. They therefore began manipulating the configurations of sign stimuli with models to define their critical features as a prelude for a neuroethological analysis. During these years in the heyday of

classical ethology, auditory signals were rarely mentioned and electric signals were unknown. At best, as an aside, vocalizations were verbally described as a 'kak, kak' or 'quok, quok' to flesh out an ethogram; a few studies made use of musical notation to describe vocalizations. But the technology was unavailable then to do much more.

That situation changed dramatically in the 1950's and 1960's, a time of technical and conceptual advances in sound recording and analysis techniques. With the introduction of the sonograph and the widespread application of communications theory, primarily Fourier analysis, acoustic signals could be quantitatively analyzed, synthesized with precision, and played back to animals under far more controlled conditions than had been possible in earlier decades or could be done with visual signals. Studies using this approach led to a realization of the diversity and subtlety of animal signals and the responses of animals to them, and highlighted the stunning adaptations of our experimental animals for processing these signals.

New tools were developed which al-

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lowed one to eavesdrop on animal signals previously unappreciated by our senses. Griffin and his students listened in on the ultrasonic world of bats and studied the acoustically-guided hunting of the barn owl; Lissmann, Bullock and Szabo probed the muddy waters of tropical streams to listen to the humming and popping of weakly electric fishes. Using the powerful tool of the sonograph, researchers addressed major questions of acoustic signals: Marler investigated the influence of environmental transmission properties and the acoustic sensitivities of potential receivers upon the evolution of call structure; Blair and his students documented the role of vocalizations in species recognition and reproductive isolation; Capra-nica and colleagues turned to study the adaptations of the nervous system for the reception and encoding of these signals. Soon these techniques and questions were focused on the electrosensory system as well, and ever since these two areas have continued to crossfertilize each other. Thus, a review of the recent progress in the neuroethology of acoustic and electric communication seemed appropriate for the first satellite symposium of the International Society of Neuroethology.

The symposium is divided into three sections. The first papers cover the neural and hormonal control of signal production. Next, we consider the role of environmental transmission properties, and biological factors, such as sexual selection, predation and background noise, in the evolution of signal systems. In this section we also include papers on behavioral strategies for maximizing signal detections. Last, we focus on neural encoding and processing of signals by the nervous system. The papers in each section stress comparisons and contrasts between the 'strategies' employed by the auditory and electrosensory systems.

We and all the participants of the symposium are grateful to Deans Robert D. King of the College of Liberal Arts and Robert E. Boyer of the College of Natural Sciences of the University of Texas at Austin for their encouragement and generous financial support. We also thank the International Society for Neuroethology for endorsement of our symposium and for financial support. In addition we would like to thank Dr. R. Glenn Northcutt for publishing the proceedings of this symposium in *Brain Behavior and Evolution*.