K.-H. Esser

Karl-Heinz Esser

1990	Dr. rer. nat., University of Bonn, Germany
	Postdoctoral work at University of Bonn and University of Ulm, Germany
1993–1999	Assistant Professor (C1), Dept. of Comparative Neurobiology, University of Ulm
1995	Assistant Professor (research), Dept. of Biology, Washington University, St. Louis, Missouri, USA
1998	"Habilitation" (Zoology and Neurobiology), University of Ulm
1999–2003	Associate Professor (C2, non-tenured), Dept. of Neurobiology, University of Ulm
Since 2003	Head of the Auditory Neuroethology and Neurobiology Lab, Institute of Zoology, School of Veterinary Medicine Hannover, Germany

Current Research

Research in this group is guided by the question of what can we learn about speech processing from animal studies [for complete review see: Speech Communication 41 (2003) pp. 179-188; Clinical Psychoacoustics (S. Nielzén, O. Olsson, eds.) Lund University Press, Lund (1998) pp. 45-59]. Conceptually, our approach (selection of species, experimental design, data interpretation) is based on a neuroethological perspective according to which the *behavior* of an animal (e.g. intraspecific acoustic communication or echolocation) is of primary importance for understanding the properties of *neural* circuits. The methodologies required include state-of-the-art (digital) sound recording, synthesis, manipulation, and presentation techniques, extracellular single- and multi-unit recordings in awake animals, cortical microstimulation, and intracerebral application of neuroactive substances and tracers. Below, work on audio-motor integration in the prefrontal cortex is taken as an example.

Audio-motor integration

Audio-motor integration takes place when an individual controls its own sound production by auditory feedback but also when a heard signal (e.g. a conspecific vocalization) elicits a behavioral reaction in the receiver. In humans, an area in the frontal lobe of our dominant hemisphere (i.e., Broca´s area and associated regions) is obviously involved in both sentence comprehension and articulation and hence commonly regarded as a key area in cortical audio-motor integration. With a six-year financial support from the interdisciplinary (neurobiology, medicine, psychology, and engineering sciences) priority program „Sensory-motor Integration" of the German Research Foundation (DFG), my students and I were able to identify a functionally analogous frontal auditory field (FAF) in *Carollia perspicillata* (an easy to breed bat from the Neotropics). In brief, the FAF is characterized by its reciprocal connections with auditory cortical regions, unusual robust single- and multi-unit responses to biologically relevant sounds (e.g. biosonar-like sound stimuli, see figure), and the elicitability of species typical (i.e., communication- and echolocation-call-like) vocalizations and jaw movements. Interestingly, both movements of the mandible and vocalizations have also been elicited in humans by intraoperative electrical stimulation of Broca's area. Being presumably the first good candidate for a „Broca's area"-analogous (homologous?) structure in a non-human mammal, the bat frontal auditory field (FAF) is a major research topic of my group for the next few years (see Goals, below).

Fig. 1

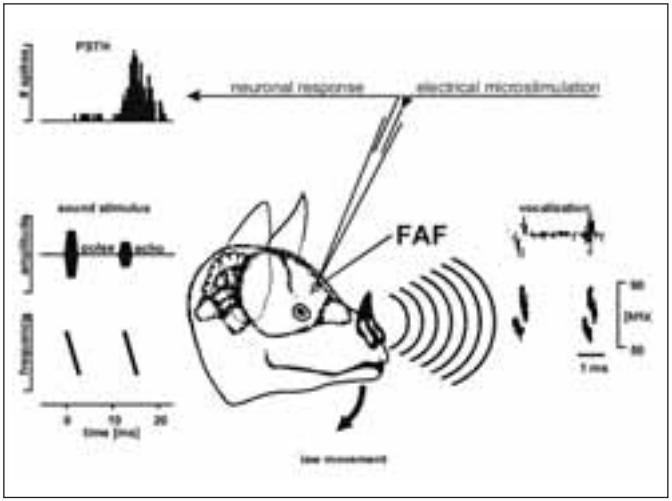

Fig. 2

Other aspects of speech processing were modelled in the lesser spear-nosed bat (*Phyllostomus discolor*, see photo) and the mustached bat (*Pteronotus parnellii*): e.g. audio-vocal learning, formation of dialects, individual recognition by voice, categorical perception of sounds, effects of delayed auditory feedback (DAF) on vocalization, and syntax processing in the non-primary auditory cortex.

Future Projects and Goals

Characterizing the bat frontal auditory field with respect to its cytoarchitecture, chemoarchitecture, and connectivity appears mandatory for addressing the question of homology (see above). Combining paradigms such as the release of vocalizations via microstimulation in the anterior cingulate cortex, manipulation of air-conducted auditory feedback, and recording from neurons in the bat frontal auditory field enables us to distinguish between sensory, motor, and sensory-motor functions (and neurons) of the FAF. Further, neuronal effects of dopamine (DA) released locally by terminals of the prefrontal dopaminergic system can be elegantly mimicked by local (e.g. iontophoretic) DA injections. Hence, dopaminergic (DA, including its agonists and antagonists) effects on (i) auditory responses, (ii) microstimulation thresholds (e.g. for eliciting vocalizations), (iii) audio-motor integration, and (iv) behavioral reactions can be studied to unravel the pharmacological nature of audio-motor integration in the prefrontal cortex, one of our long-term research goals.

Selected Publications

[1] Esser, K.-H., C.J. Condon, N. Suga, and J.S. Kanwal (1997) Syntax processing by auditory cortical neurons in the FM-FM area of the mustached bat *Pteronotus parnellii*. **Proc. Natl. Acad. Sci. USA** 94:14019-14024.

[2] Esser, K.-H. and A. Eiermann (1999) Tonotopic organization and parcellation of auditory cortex in the FM-bat *Carollia perspicillata*. **Eur. J. Neurosci.** 11:3669-3682.

[3] Eiermann, A. and K.-H. Esser (2000) Auditory responses from the frontal cortex in the short-tailed fruit bat *Carollia perspicillata*. **NeuroReport** 11:421-425.

[4] Kanwal, J.S., M. Gordon, J.P. Peng, and K.-H. Esser (2000) Auditory responses from the frontal cortex in the mustached bat, *Pteronotus parnellii*. **NeuroReport** 11:367-372.

[5] Egorova, M., G. Ehret, I. Vartanian, and K.-H. Esser (2001) Frequency response areas of neurons in the mouse inferior colliculus. I. Threshold and tuning characteristics. **Exp. Brain Res.** 140:145-161.

Group Structure

Group leader:	Karl-Heinz Esser
Graduate student:	Oliver Schaper
Undergraduate student:	Sönke von den Berg
Technician:	Elisabeth Evers, Karsten Instenberg, Rüdiger Brüning
Animal husbandry:	Wolfgang Mehl, Achim Sauer

Contact

PD Dr. Karl-Heinz Esser
Auditory Neuroethology & Neurobiology Laboratory
Institute of Zoology
School of Veterinary Medicine
Bünteweg 17
30559 Hannover
Germany
Phone: +49-511-953-8420
Fax: +49-511-953-8586
Email: kalle.esser@tiho-hannover.de
Web: http://www.tiho-hannover.de/einricht/zoo/index.htm