DEPARTMENT OF AUDITORY NEUROSCIENCE

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LABORATORY OF AUDITORY PHYSIOLOGY AND PATHOLOGY

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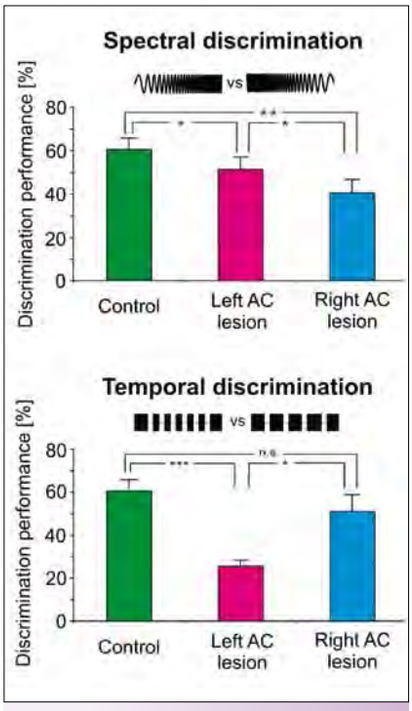
RESEARCH TOPICS

The Department of Auditory Neuroscience has existed since the foundation of the Institute of Experimental Medicine in 1975. The main research aims of the department are oriented towards investigations of the structure and function of the auditory system in animals and man under normal and pathological conditions and during ontogeny and ageing.

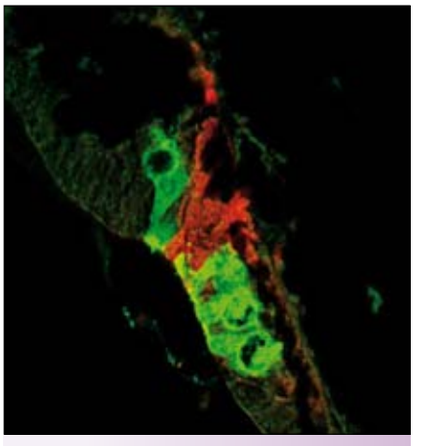
Laboratory of Auditory Physiology and Pathology

In the Laboratory of Auditory Physiology and Pathology, recordings of neuronal activity in individual auditory centers using multielectrodes have revealed the basic principles of the neuronal processing of simple tones as well as complex sounds such as artificially generated rippled noise or animal vocalizations. The development of the hearing organ during ontogeny and changes in the expression of calcium-binding proteins and other neuroactive substances are studied with immunostaining



Direction of frequency modulation discrimination *(Spectral discrimination) was more deteriorated after right auditory cortex (AC) lesion, whereas discrimination of gap repetition rate in noise (Temporal discrimination) was significantly worsened following left AC inactivation.*

methods and confocal microscopy analysis. Behavioral conditioning tests associated with permanent or pharmacologically-induced reversible lesioning of cortical structures are used to study the lateralization of auditory functions in the rat auditory cortex. Pathologies of the peripheral and central parts of the auditory system, appearing as a consequence of noise exposure or in conjunction with aging, are investigated in experimental animals and in human subjects. Among the methods used in the laboratory for this purpose are the recording of extracellular single neuron activity and auditory evoked responses, the assessment of hearing thresholds, measurements of psychoacoustic functions, the startle reaction, the recording of different types of otoacoustic emissions, as well as immunohistochemical and western blotting techniques used for evaluating changes in the expression of neuroactive proteins in the peripheral and central parts of the auditory system

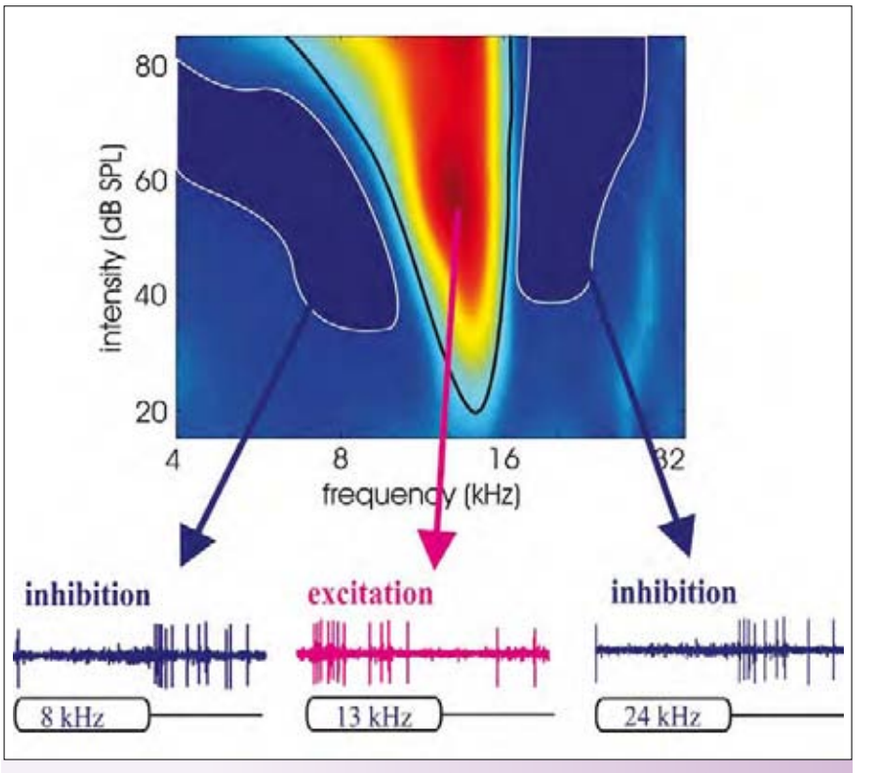


Calbindin (green) and S100 protein (red) in the organ of Corti *in mice at postnatal day 4.*

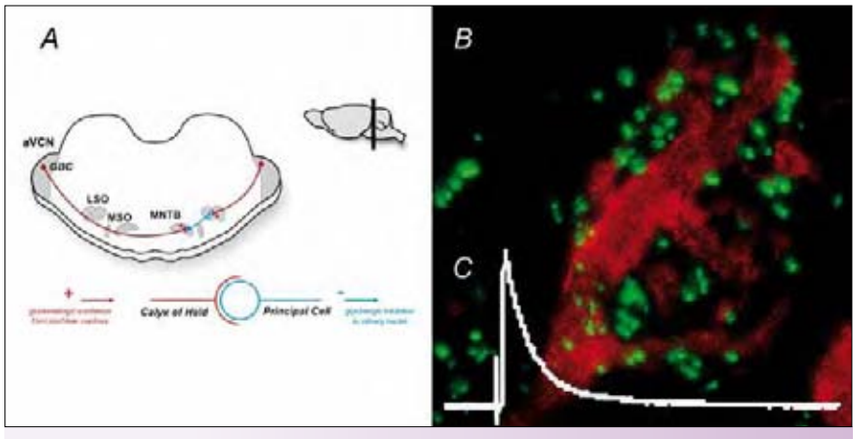
in experimental animals. Age-related changes of hearing function are investigated in special strains of rodents with accelerated aging (C57 mice or Fischer 344 rats). Special attention is given to the GABA inhibitory system in the central auditory pathway, since it is known that this system is vulnerable when animals are exposed to noise and during aging. Collaboration with ENT clinics is oriented towards investigations of hearing function in children and adolescents, the characterization of presbycusis and the genetic background of inherited deafness. Possible methods for the prevention or treatment of inner ear diseases by the application of biologically active drugs or genes to the cochlea are experimentally tested using nanoparticles as a targeted transporting tool.

Laboratory of Synaptic Physiology

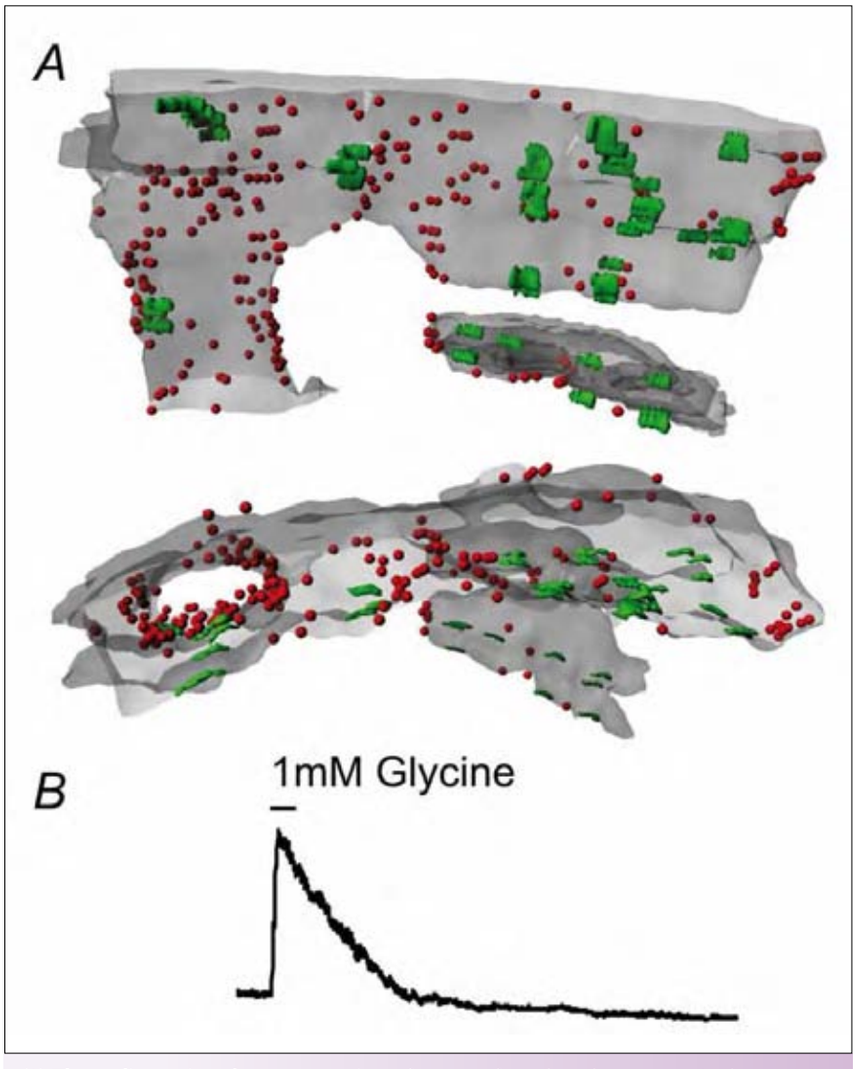
In the Laboratory of Synaptic Physiology the mechanisms underlying the plasticity of excitatory and inhibitory synaptic transmission are studied in rodent brain slices using electrophysiological and immunohistochemical techniques. The Calyx of Held synapse in the medial nucleus of the trapezoid body (MNTB) is mostly used as a model of the central type of synapse due to its large size enabling direct examination by the patch-clamp technique. Recent projects in the lab are aimed at revealing the physiological roles of inhibitory transmitters, their receptors and uptake systems in the MNTB neurons.



Excitatory and inhibitory response areas *of a neuron recorded in the inferior colliculus in the rat to tones of variable frequencies.*



(A) A scheme representing a rat brainstem slice with auditory nuclei. Ventrally situated, the medial nucleus of the trapezoid body (MNTB) is composed of giant nerve terminals (calyx of Held) and principal cells.
(B) A confocal image of double fluorescence labeling. The calyx of Held, which is surrounding a principal cell was labeled with an antibody raised against calretinin (red). Note clusters of postsynaptic alpha 1 subunit-containing glycine receptors (green).
(C) Inhibitory postsynaptic current recorded from a MNTB principal cell evoked by stimulating small glycinergic terminals.



(A) ***Three dimensional reconstruction*** *of a part of a calyceal nerve terminal containing glycine receptor alpha 1 subunits (red dots) and glutamate release active zones (green stripes).*
(B) Current response of presynaptic glycine receptors evoked by the application of glycine on the calyx of Held.

Experimental work has provided evidence of the novel excitatory nature of the classical inhibitory transmitters GABA and glycine. The results show that chloride-permeable glycine receptors, G-protein coupled GABA-B receptors, N-type Ca^{2+} channels and calcium-activated potassium conductances work in concert to support the extremely high reliability of glutamatergic synaptic transmission at MNTB neurons.

CURRENT GRANT SUPPORT

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Center of Neuroscience.

GA CR, 309/07/1336, Acoustical signal processing in the neuronal circuits of the auditory system.

GA CR, 309/06/1304, The role of GABA-B receptors in the mammalian MNTB.

EU 6th FP, Nanoear, NMP-2004–3. 4. 1. 5–1.

EU 6th FP, Synapse, LSHM-CT-2005-019055.

Wellcome Trust, No. 073966.

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