Experimental Setup for Assessing the Efficacy and Quality of Retina Implant Stimulations by Retinal and Cortical Recording in Cat

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Introduction. It has been shown that patients that are blind due to photoreceptor degeneration caused by retinitis pigmentosa or macular degeneration are able to perceive localized phosphenes if their retinal surface is electrically stimulated by a small electrode. This shows that the electrical stimulation of retinal ganglion cells may be used for a neural prosthesis for restoring vision. However, the development of retina−implants requires extensive testing in animals before applications in humans are possible. **Methods.** We developed methods for epi− and intra−retinal micro−stimulation to optimize spatio−temporal selectivity while using minimal electrical energy in anesthetized cats semi−chronically prepared for repeated experiments. A novel retina−manipulator (11 deg. of freedom) was developed in order to reach most retinal positions without stressing the penetrated eye. Multiple micro−electrodes as well as thin film electrodes (IBMT, St. Ingbert) were inserted into the cat's eye through a small entry (≈ 1 mm ∅, above mu. rect. lat., 4 mm behind limbus) without causing any sustaining harm, and placed under visual and recording control near the membrana limitans interna. A fast isolation unit, a programmable stimulation−recording device and a real−time adaptive artifact suppression was developed for effective recordings. Electrode properties were monitored by impedance spectroscopy, cyclovoltametric measurements and current impulse spectroscopy. Success of stimulation was assessed 1.) by *retinal recording* of ganglion cell spikes via the stimulation electrode, and 2.) by *recording of cortical responses* from area 17/18 via a multiple micro−electrode array (Eckhorn & Thomas, J Neurosci Meth 49, ´93). Classical and dynamic receptive field mapping (Eckhorn et al. Biol Cybern 69, ´93) were obtained for all retinal and cortical positions from single−unit and mass activities in different combinations with the stimulation electrodes' position. Our methods enable us to distinguish fiber and soma stimulation by 1.) recording from axons or somata by the stimulation electrode, and 2.) by comparing the RF−positions of retinal and cortical neurons activated by the same stimulation site. While retinal soma stimulation activates cortical neurons at the corresponding projection site, axonal stimulation activates neurons at other cortical positions. In this preparation the adequacy of electrical stimulation can also be tested with natural visual stimulation via the non−implanted eye, because the response spike patterns can be compared in the same binocularly excitable cortical neuron to both stimulation modes. **Conclusion.** Our approach allows the optimization of spatio−temporal current distributions for selective stimulation of ganglion cells while minimizing stimulation energy. (Supported by BMBF grants to R.E. and L.H.)