Assessing potential changes in cortical receptive field properties after electrical stimulation of the cat´s retina. Development of an epi−retinal prosthesis

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Introduction. It has been shown that blind patients with degenerated photoreceptors perceive localized phosphenes when their retinal surface is electrically stimulated. These retinal stimulations were crude, especially with respect to appropriate functional activation. In addition, due to the limited size of retinal electrode arrays developed to date, a considerable retinal fraction is not activated leaving part of the cortex unused. It is so far unclear how the cortex will interpret "pseudo−visual" electrical input, but it is expected, that adaptations will be driven by the cortical tendency of optimizing its information processing capabilities. In intact visual systems the primary cortical areas are concerned with the representation of Gestalt principles. A retinal prosthesis should therefore be adapted to the evolved neuronal network and feed the visual cortex with stimuli that are based on these principles. **Goal.** In order to assess the visual cortex´ ability to make sense of electrical stimuli we want to know, whether cells in cat area 17/18 change their receptive field (RF) properties beyond merely increasing excitability or enlarged RF size. In particular, we want to know whether existing orientation and directional movement tunings are influenced and changed by electrical stimulation of the retina. **Methods.** Normal cats will have an electrode array implanted epiretinally into one eye (the "implanted eye") [1]. This will stimulate the retina electrically by spatio−temporal impulse distributions that resemble simple Gestalt features. For example, *form* can be generated by activating a row of electrodes simultaneously, while *movement* is generated by systematically shifting synchronized groups of electrodes in retinal space. RF−mapping of cells in area 17/18 including RF−position, orientation and movement direction is made visually (vRF) via the intact eye as well as electrically (eRF) by the electrode array in the implanted eye. Correlation analyses between the activity recorded at different cortical recording positions can be used to unravel alterations in coactivity due to synchronous activation of retinal cells as has been shown to be operative in the somatosensory modality [2]. **Expectations.** Location and size of cortical vRFs are expected to change in correspondence to findings in scotoma studies [3], although the situation is inverted, since electrical input is constraint to rather than expelled from small stimulation spots (scotomata). If the stimulation array is oriented non−colinearly to the preferred orientation of the recorded cortical cells, synchronous electrical stimulation of the retinal cells along the contour should alter the cortical cells´ orientation selectivity as mapped visually prior to or electrically after implantation. Alterations should occur towards the retinal array´s orientation. Since the synapses in the pathways of the visually intact eye are separated from those of the implanted, the vRF properties of binocularly driven cells should not alter if driven by the electrically non−stimulated eye, in accordance with results from scotoma experiments [3]. Therefore, after electrical stimulation of the retina, remapping of the RFs should unravel distinct monocular orientation tuning. Coactivation of cells across the stimulated area as measured by correlation analyses give insights into the relationship between cortical reorganization and cooperative processes. Though, how closely an electrical stimulus can reproduce a physio−logical input may be determined by how physiologic the cortical cells´ response properties are.

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[1] Fraunhofer Institutes: IBMT, St. Ingbert (J.−U. Meyer) & IMS, Duisburg (W. Mokwa)

[2] Dinse et al. (1993): NeuroReport 5, 173−176.

[3] Schmid et al. (1996): Cerebral Cortex 6, 388−405.