

Spatial and Temporal Visual Resolutions with Retina-Implants Estimated from Recordings in Striate Cortex of Cats

R. Eckhorn*, T. Schanze*, M. Wilms*, M. Eger*, L. Hesse⁺, P. Kroll⁺

*Group of NeuroPhysics, Department of Physics, Renthof 7

⁺Department of Ophthalmology, Robert-Koch-Str. 4
Philipps-University, D-35032 Marburg, Germany

Blind persons with photoreceptor degeneration and intact retinal ganglion cells can perceive phosphenes elicited by intraocular electrical stimulation. For ethical reasons we avoid explorative experiments to determine perceptual resolutions feasible with electrical retina stimulation in blind humans. Instead we use the anesthetized cat as an animal model. It allows to estimate the spatial and temporal resolutions achievable with retina implants by electrical retinal micro-stimulation and simultaneously recording of evoked cortical activations with arrays of micro-electrodes in visual cortical area V1 (and V2). *Spatial resolution*: We determine the cortical activation spread from multiple-site recordings of responses to a single focal retinal stimulus. Then, the cortical activity profile is transformed to visual coordinates according to the local retino-cortical magnification factor. Alternatively, we use multi-focal retina-stimulation and single-site cortical recording in order to determine the size of cortical electrical receptive fields, thereby extending the concept of visual receptive fields. *Temporal resolution* is determined from the time course of the cortical responses. After optimizing these methods we obtained spatial resolutions of about 1° visual angle (minimal 0.66°). This resolution may enable many practical capabilities in everyday life. The measured temporal resolutions may allow the perception of 20 to 30 picture frames per second if two-level contrast is sufficient (during analyses of dynamic scenes). If 2 to 3 frames per second suffice, as during normal fixation sequences, about 10 levels of contrast could be encoded. However, we have to keep in mind that our resolution estimates were made in anesthetized animals with intact retinae. Whether patients with degenerated photoreceptors will perceptually achieve similar values can only be determined by direct tests in direct dialog with patients.

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