Single neuron recordings in human cerebral cortex: a source of fundamental information to functionally characterize the brain tissue at the border of low-grade gliomas.

The neurophysiology of human cortex mainly bases on functional mapping achieved by brain imaging (PET, fMRI) and electrophysiology techniques (EEG, ECoG, MEG). These techniques have severe limitations because of poor temporal or spatial resolution. Single-neuron recordings in humans have been rarely performed and almost exclusively in pathological brain tissue.

We report a new method to functionally map the healthy tissue surrounding cerebral gliomas of patients undergoing neurosurgery. This method has been used in conjunction with brain surface electrical stimulation in the awake patient. In the last year, more than 100 patients have been surgically treated for low grade gliomas. Before surgery, on the basis of the lesion site, each patient underwent both neuropsychological testing and fMRI scan while performing motor, perceptual and linguistic tasks selected from a library of fMRI protocols previously tuned on normals. Functional MRI activations were then superimposed on 3D anatomical MRI data to execute neuronavigation. During surgery, patients' peri-lesional cortex was functionally mapped by ECoG and bipolar constant-current stimulation. Moreover, on 10 patients showing lesions close to functionally relevant areas, we performed single-unit recordings by means of a 4-microelectrode motorized microdrive allowing to online co-relate the activity of isolated single neurons with patient's sensorimotor and language-related functions. Importantly, some of the recording electrodes were inserted in the tumoral tissue, providing information about the presence of functionally relevant neural activity. Finally, on 24 patients, a further control fMRI scan was performed after recovering from the operation.

The integrated use of these techniques has been shown to: (1) Ameliorate the surgical approach and outcome and (2) better understand the neurophysiology of human cortex, particularly concerning sensorimotor transformations and language-related functions.