REGIONAL IFFERENCES OF REACTIVE RESPONSES AGAINST SILICON NEURAL PROBE IMPLANTED INTO DEEP BRAIN REGIONS

S.J. Oh[1], K.L. Smith[2], C.S. Bjornsson[2], J.N. Turner[2], J.K. Song[1], S.J. Kim[1], and W. Shain[2].
[1]Nano Bioelectronics and Systems Research Center, Seoul National University, Seoul 151-744, Korea. [2]Lab of Nervous System Disorders, Wadsworth Center, Albany, NY 12201-0509.

It has been over 20 years since micro-machined silicon neural probes were invented; however, their full potential for neural prosthetic applications and neuroscience has not been realized. Their chronic use is limited due to glial encapsulation that electrically isolates devices from cellular networks. While these reactive responses are well characterized in cortex, the responses of other regions are unknown. Responses to inserted devices are particularly relevant to deep-brain stimulating electrodes, which are currently used in treating a number of neurological disorders.

We examined time-dependent changes in neocortex, hippocampus, and thalamus using immunohistochemistry and confocal microscopy (Fig. 1). Device shafts were 5 mm long and 50 m x 128 m in cross-section. Antibodies to GFAP (astrocytes), laminin (vasculature), and CD11b (microglia) were used to assess reactive responses around insertion sites at 1 hr, 24 hrs, 1 wk, and 6 wks. Results show dramatic differences in the magnitude of cellular response in different brain regions. Immuno-reactivity in the hippocampus was stronger than in other regions (Fig. 2). In thalamus, staining for GFAP and laminin were relatively less intense, while CD11b was comparable. Laminin expression in all regions extended considerable distances from probe sites at 1 hr, and decreased at later times.

These data suggest that soluble signals may control the extent and magnitude of responses in different brain regions. Many prosthetic devices currently under development are organized into multishank arrays, which may result in overlapping spheres of influence and elevated responses between shanks. We are testing this hypothesis in neocortex, hippocampus, and thalamus using comb electrodes with different spacing between shanks. This study was supported by the International Collaboration Program of NBS-ERC/KOSEF and NIH/NIBIB, R01-EB-000359.

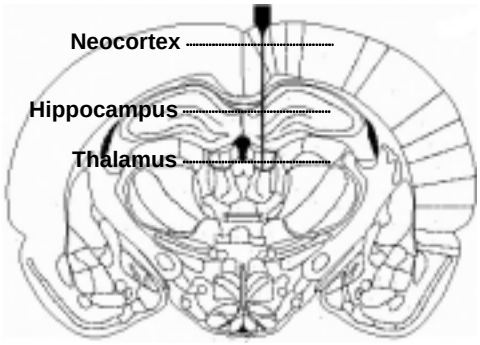

Fig.1. Schematic view of probe location

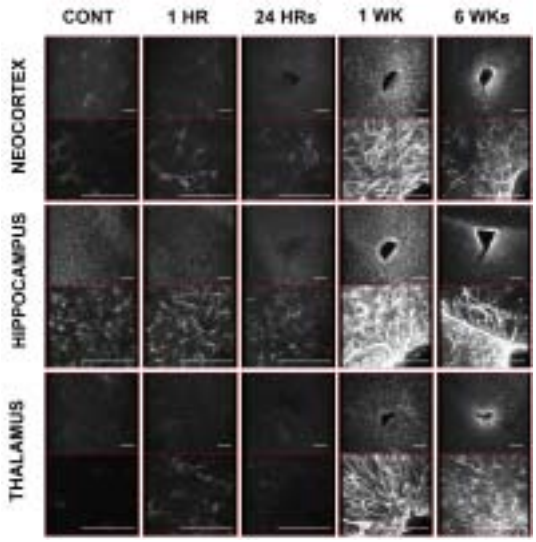

Fig. 2. Immunoreactivity of GFAP