

THE DYNAMICS OF EVOKED AND ONGOING ACTIVITY IN THE BEHAVING MONKEY.

D. B. Omer and A. Grinvald

Dept Neurobiology, Weizmann Inst for Science, Rehovot, Israel.

Previous findings from Voltage Sensitive Dye Imaging (VSDI) experiments done on anesthetized cats (Grinvald et al., 1989; Arieli et al., 1995; Arieli et al., 1996; Tsodyks et al., 1999; Kenet et al., 2003) indicated that the amplitude of ongoing activity (primarily synaptic potentials) is large, suggesting that it may play an important role in cortical processing by affecting the evoked activity and therefore the final behavior itself. VSDI was recently implemented also on the awake monkey (Slovin et al., 2002; Seidemann et al., 2002;) allowing monitoring of activity from the same patch of cortex, repetitively, for more than a year. We investigated the cortical activity in the primary visual cortex of a behaving monkey during both evoked and ongoing conditions. Several questions have been addressed: what are the spatial-temporal characterizations of the ongoing activity in early visual areas of the behaving monkey? How is it related to the functional architecture? We combined simultaneous VSDI with electrophysiological recordings of the local field potential (LFP) single and multi unit activities. In the evoked condition, the monkey was trained to fixate for 10s while presented with a full field moving grating. We found that our fast switching stimuli abolished the high frequency oscillations at about 30Hz, oscillations that were present in the absence of a stimulus. During the ongoing condition, the monkey was required to sit quietly in a totally dark room. We found that the VSD signals in both conditions are often highly similar to the LFP, just like in the anesthetized cat. The similarity between the VSD signals and LFP was highest within the α (9-14 Hz) frequency band. For the awake monkey, the ratio between amplitude of ongoing and evoked activity was much smaller than what was found in the anesthetized cats. However, extensive spike triggered averaging (STA) of the VSD signals revealed coherent spontaneous activity also in the awake primate. Some cells exhibited coherent activity with large assemblies in both area V1 and V2. Cortical states related to orientation representations, if any had a short life time and short coherence length, much smaller than those found in the anesthetized cats. These results suggest that ongoing activity is richer in fast spatio-temporal patterns in awake animal. Therefore, it may play multiple functional role in the awake primate, rather than being an epiphenomenon of anesthetized preparations. However the exact functional role remained to be evaluated.

Related References

Grinvald A., R.D. Frostig, D. Y. Ts'o, E. Lieke, A. Arieli and R. Hildesheim. Optical Imaging of Activity in the Visual Cortex. in "*Neuronal Mechanisms of Visual Perception*" D. Lam and C.D. Gilbert Eds. pp 117-136. 1989.

Arieli A., D. Shoham, R. Hildesheim and A. Grinvald. Coherent spatio-temporal pattern of on-going activity revealed by real-time optical imaging coupled with single unit recording in the cat visual cortex. *J. Neurophysiol.* 73, 2072-2093, 1995.

Arieli A., A Sterkin, A. Grinvald and A. Aertsen. Dynamics of on-going activity: Explanation of the large variability in evoked cortical responses. *Science*, 273, 1868-1871, 1996.

Tsodyks M., T. Kenet, A. Grinvald and A. Arieli (1999). Linking spontaneous activity of single cortical neuron depends and the underlying functional architecture. *Science*, 286, 1943-1946.

Shtoyerman, E., A. Arieli, H. Slovin, I. Vanzetta and A. Grinvald (2000). Long term optical imaging and spectroscopy reveal mechanisms underlying the intrinsic signal and stability of cortical maps in V1 OF behaving monkeys. *J. Neuroscience*, 20, 8111-21.

Seidemann E, Arieli A, Grinvald A, Slovin H. (2002) Dynamics of depolarization and hyperpolarization in the frontal cortex and saccade goal. *Science*, 295(5556):862-865.

Slovin, H., A. Arieli, R. Hildesheim, and A. Grinvald (2002). Long-term voltage-sensitive dye imaging of cortical dynamics in the behaving monkey. *J. Neurophys.* 88: 3421-3438.

Kenet, T., A. Grinvald, M. Tsodyks, A. Arieli (2003). Spontaneously occurring cortical representations of visual attributes. *Nature*, 425:954-956.

Omer, D. B. Rom, L. Grinvald, A.(2006). The dynamics of ongoing activity in the primary visual cortex of the awake monkey. *NS abstract*