Orientation tuning of the local field potential and multi-unit activity in the primary visual cortex of the macaque

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Oscillations in the local field potential (LFP) are abundant across species and brain regions. The possible relationship of these low-frequency extracelluar voltage fluctuations with the activity of the underlying local population of neurons remains largely elusive. To study this relationship, we used an array of chronically implanted tetrodes spanning a distance of 700 µm and simultaneously recorded action potentials from multiple well-isolated single units, multi unit activity (MUA) and LFP from area V1 of the awake, behaving macaque. Moving and static gratings of different orientations were used for visual stimulation.

In agreement with previous studies we find that the increase of LFP gamma-band power is a function of the orientation of the stimulus. However, the power of the gamma-band contains much less information about the orientation of the stimulus than the MUA and SUA recorded at the same site (Figure 1A). The average discriminability d' between preferred and orthogonal orientation was 2.46 for MUA, 2.45 for SUA and 1.01 for the LFP. Moreover, in contrast to recent results from area MT (Liu and Newsome, 2006) we find only a weak correlation between the preferred orientation of the MUA tuning function and that of the LFP (Figure 1B, different colors indicate different animals). Interestingly, all nearby LFP recording sites in our array were tuned to a similar orientation while the preferred orientations of MUA tuning functions were widely scattered. These results suggest that the power of LFP signals does not capture local population activity at the scale of orientation columns in area V1.

Literature:
Liu J, Newsome WE (2006) Local Field Potential in Cortical Area MT: Stimulus Tuning and Behavioural Correlations, J Neurosc 26:7779-7790