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INTERPRETING HIGH-FREQUENCY OSCILLATIONS IN THE BRAIN: MECHANISMS AND MEANINGS

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ABSTRACT

Establishing a link between brain activity recorded at the micro scale (at the level of single cells) and macro scale (whole brain dynamics) has been a long-standing challenge. High-frequency oscillations (HFOs, 80-250 Hz) visible in the electrical brain activity are a promising candidate for the missing bridge as they can be observed both in micro- and macroscopic recordings. Their interpretation is, however, complicated, as HFOs are a compound measure of various electrical processes in the brain, and their precise mechanism of generation still remains unknown. In my talk, I will first discuss the context of brain oscillations and then present results of my research group obtained from a publicly available dataset of recordings from the visual cortex of macaque monkeys in various behavioral states. Based on the shapes of recorded neuronal action potentials, we identified six classes of cells that exhibit a differential relationship to HFOs. Particularly, one class of cells shows a strong preference for spiking at the peak of the HFO, while most other classes prefer to spike at the trough. We hypothesize that the strongly peak-locking class acts as a generator of the locally observed oscillation, while other classes are recruited through synaptic coupling. Moreover, two classes of cells behave differently with respect to HFO when the eyes are open and closed, possibly reflecting dependence on brain-state-related external input. Finally, we compare the spatiotemporal dynamics of HFOs during the resting state and a visual task. In the resting state, HFOs appear as bursts of strong oscillatory activity, mostly when the eyes are closed, and horizontally propagate across the cortex. During visual tasks, HFOs reflect the structure of the visual experiment, but locally resemble the resting HFO activity. Altogether, our results bring novel insights into the mechanism of generation and possible function of HFOs.