Phase-based analysis reveals propagating waves during single-trial voltage sensitive dye imaging of visual cortex in awake behaving monkey

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New multichannel recording methods at the mesoscopic scale have recently generated much interest in the spatiotemporal interactions within and among brain areas. Large, low-frequency propagating waves of activity have been observed during anesthetized brain states in many species, while voltage-sensitive dye imaging (VSDI) in awake behaving monkeys has typically observed a unimodal spread of activity in response to stimuli. Because of the technical and noise limitations of VSD imaging, however, averaging over many trials was necessary in previous studies, and potentially precluded the detection of trial-variable propagating events. With the aid of denoising methods developed specifically for analyzing VSDI data at the single-trial level, here we report the existence of spontaneous and stimulus-evoked propagating waves of activity in the primary visual cortex of the awake, behaving monkey. We quantify these stimulus-evoked propagating waves using a phase-based approach, and observe that the response latency and the distribution of propagation speeds differ across trials, limiting the extent to which averaged signals can capture these variable dynamics. We go on to examine potential functional roles of these trial-based propagating events in the context of the interaction between multiple stimuli and brain areas on the planar surface of the cortex, and relate these new findings to previous studies of the population activity in primary visual cortex.

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