“Dynamics of visual representations in the primary visual cortex of mice during rivalrous stimulus presentation”

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Binocular rivalry occurs in human and non-human primates when the two eyes are presented with conflicting images in the binocular visual field. Instead of generating a subjective experience of a merged image, the perceived image alternates coherently between the stimulus presented to one eye or the other. Electrophysiological and imaging studies have provided evidence that the image that is dominant during binocular rivalry is determined by both bottom-up and top-down factors. Here we study binocular rivalry as a paradigm to investigate top-down regulation of visual representations in the sensory cortex. Until now, binocular rivalry has not been comprehensively described in rodents which, if they exhibited rivalry, would allow a more in-depth understanding of the circuit mechanisms of this phenomenon. In this study, we develop an experimental approach to assess binocular rivalry in mice while functionally imaging and decoding the activity of the sensory cortex. A mirror system was used to present binocularly matched or mismatched drifting gratings, natural images, or natural movies to awake head-fixed mice, while neural activity was monitored in the primary visual cortex using 2-photon calcium imaging. Visual cortex representations were decoded using a support vector machine.

Consistent with previous reports we found that most binocular neurons responded preferentially to binocularly matched grating stimuli and in general the input driven by the contralateral eye dominated the visual cortex representation unless stimulus contrast was controlled to counteract this. Consistent with a rivalry-like process, we observed that during presentation of conflicting stimuli, visual cortex representations are less predictable than during presentation of binocularly matched stimuli. During mismatched presentations, representations were also often highly similar to those elicited by monocular presentation of one of the two rivalrous stimuli. These results are consistent with a rivalry-like process occurring at the level of primary visual cortex in mice.