Title: Neurophysiological differentiation is greater in response to ecologically-relevant vs. ecologically-irrelevant stimuli in mouse visual cortex

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Abstract: 2.34

When we see ecologically-relevant (ER) stimuli, our visual system is able to extract both low- and high-level spatiotemporal structure. By contrast, when viewing ecologically-irrelevant (EI) stimuli, e.g. phase-scrambled movies or white noise, we do not as readily extract meaningful patterns. The patterns of neural activity underlying stimulus representation should therefore be more differentiated in response to ER stimuli. Previous work using EEG and fMRI in humans showed that neurophysiological differentiation is greater in response to ER compared to EI stimuli. However, these methods lack the spatial resolution required to determine which brain areas drive this increase in differentiation; for example, it is unclear whether the effect is driven by differences among representations in primary vs. higher visual areas. In this work, we aimed to (1) replicate in mouse visual cortex the effects in humans and (2) probe the specific roles of different visual areas and cortical layers in driving these effects.

We created movie stimuli of different levels of putative ecological relevance, e.g. predators, conspecifics, white noise, etc. We used phase scrambling to create EI stimuli with matched power spectra. Through the OpenScope platform of the Allen Institute for Brain Science, we leveraged the standardized, high-throughput Allen Brain Observatory pipeline for in vivo two-photon calcium imaging to measure the neurophysiological differentiation of responses to these stimuli in mouse visual cortex.

We found that neurophysiological differentiation was greater in response to ER stimuli compared to EI stimuli, replicating the EEG/fMRI findings in humans. We found specific differences among visual areas and cortical layers: the difference between ER and EI differentiation was more pronounced in higher areas and in layers 2/3 and 5 compared to layer 4. Crucially, these differences could not be explained by low-order differences in stimulus statistics, such as luminance, contrast, optical flow, and others.