

Shifted Encoding Strategy in Retinal Luminance Adaptation: From Firing Rate to Neural Correlation

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Neuronal response to prolonged stimulation attenuates over time. Here, we ask a fundamental question: is adaptation a simple process for the neural system to ignore the sustained input, or it actually underlies a strategy for the neural system to utilize resources efficiently to encode the stimulus information. Through simultaneously recording the activities of a group of bullfrog's retinal ganglion cells (dimming detectors) in response to sustained dimming stimulations, we applied a combination of information analysis approaches to explore the time-dependent nature of information encoding during the adaptation. We found that at the early stage of the adaptation, the stimulus information was mainly encoded in firing rates; whereas at the late stage of the adaptation, it was more encoded in neuronal correlations. Such a transition in encoding properties is not a simple consequence of the attenuation of neuronal firing rates, but rather involves an active change in the neuronal correlation strengths, suggesting that it is a strategy adopted by the neural system for functional purposes. Our results reveal that in encoding a prolonged stimulation, the neural system may utilize concerted, but less active, firings of neurons to encode the information, a strategy which is economically efficient.