Nghi Huynh
ID: 260632588
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The visual system relies on information extracted from highly variable natural signals to allow animals to estimate and control their current direction. In this paper, the authors address the *Drosophila* visual system's underlying mechanism, especially how it attains the robustness of visual motion responses in real-world environments. They conducted behavioral and electrophysiological experiments to investigate how the fly visual system regulates contrast variability. Then, they designed a fly-like neural network and trained it to demonstrate how dynamic signal compression based on divisive contrast normalization improves robustness to visual motion responses in flies.

Specifically, the authors performed behavioral experiments and found that surround contrast regulates the sensitivity of optomotor responses in flies. Then, they used two-photon calcium imaging to all principal neurons in the motion circuit (Figure 1) to further trace back to the emergence of signal compression. They found that transient medulla neurons of the fly optic lobe are the neural origin of it. Moreover, the combination of medulla neurons is critical neural feedback underlying divisive contrast normalization in the fly. These findings suggest that divisive contrast normalization occurs in the fly visual system.

Then, they designed and trained convolutional neural networks to evaluate three models for contrast transformation: a linear model, a statically compressive model, and a dynamic compression model (Figure 2). They then tested these models on the same set of stimuli and compared these models, a standard elementary motion detector (EMD), and motion responses in flies (Figure 3). They found that although linear and static models exhibited improved velocity tuning curves compared to the standard EMD, these models still not accounted for time variability as in motion responses in flies (Figure 3D, 3E, and 3F). In contrast, dynamic models were extremely robust at extracting scene motion across time, images, and velocities similar to motion responses in flies (Figure 3F and 3D). These findings suggest that signal compression for robust motion vision in flies is dynamic.

Overall, this study not only demonstrates the divisive contrast normalization in the *Drosophila* visual system, but it also reveals a comprehensive mechanism underlying the non-linear response properties in the fly motion vision circuit. Furthermore, the convolutional network used here may provide a foundation for machine vision systems in autonomous vehicles or future mechanistic inquiries in other sensory systems such as fly olfaction or mammalian auditory cortex.