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“Our brains respond to changes in our environment with an almost infinite repertoire of behaviors. I am interested in understanding how neural circuits sense and process information to generate behaviors.”

Our brain contains roughly 100 billion cells, each connected through thousands of contact points, adding up to at least a quarter of a million miles of wiring—enough to reach from here to the moon. This marvel of evolutionary engineering allows us to navigate an ever-changing environment, to learn and to remember, but its stunning complexity makes it difficult to trace how information travels from one neuron to another. The Chalasani lab uses the nematode Caenorhabditis elegans (C. elegans), as a model to understand how neural circuits transform sensory input into behaviors. Despite its simplicity, C. elegans displays a number of sophisticated behaviors, making it an ideal model to explore how a simple, well-defined nervous system is able to integrate information from multiple sensory neurons and remember it for long periods of time.

The worms spend about 15 minutes searching for food when they are moved from a plate with food to a food-free plate. The duration of this search time is a function of the quality of the food and the amount of time they have spent feeding on it before being moved. The worms are able to learn the size of a food patch they were growing on and remember it for at least one hour. Chalasani and his team have localized the spatial memory to a pair of interneurons and identified a crucial role for dopamine signaling in executing this behavior.

C. elegans neural circuits integrate multiple sensory inputs to generate complex behaviors. Chalasani has identified that sensory neurons use neuropeptides (small signaling molecules) to communicate information about the identity and strength of the sensory stimuli to the rest of the nervous system. Neuropeptide signaling represents a new approach for coding sensory information in the brain.

He and his group have also observed an interesting predator-prey relationship between C. elegans and a larger worm called Pristionchus pacificus. They found that C. elegans uses three previously undefined sensory neurons to detect and avoid predators and their secretions. Surprisingly, pre-treating the worm with human anti-anxiety drugs attenuates its response to the predator.

In the future, Chalasani plans to extend his lab’s studies to zebrafish larvae to test whether vertebrate and invertebrate circuits use similar mechanisms to process information, hoping to gain new insight into how the human brain functions.

For more information, please visit www.salk.edu/faculty/chalasani

From left to right: Eunice Lau, Kevin Curran, Sarah Leinwand, Shrek Chalasani, Stuart Ibsen, Laura Hale, Adam Calhoun, Ada Tong and Bryan Arias