Journal Club

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Appetite for Destruction: Neuron Ablations, Prey Capture, and Sensorimotor Integration in Larval Zebrafish

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Review of Gahtan et al. (http://www.jneurosci.org/cgi/content/full/25/40/9294)

Neuroethology has developed as a branch of neuroscience with the explicit goal of linking neural activities to behavior. Among experimental animals, zebrafish are particularly promising in this regard. The ability to optically image single neurons *in vivo*, combined with the relative small number of neurons, provides a unique opportunity to link the activity of identified neurons with behavior. Although much is known about the morphological aspects of sensory and motor systems in zebrafish, we are just beginning to learn about sensorimotor integration, i.e., how sensory signals are translated into neuronal responses (Niell and Smith, 2005) and then into motor commands that direct behaviors.

There are few well studied vertebrate neural networks that produce a specific stereotyped behavior. Such networks have been best characterized in invertebrates, such as the sea slug *Aplysia californica* and the nematode *Caenorhabditis elegans*. Even the relatively simple Mauthner-cell-mediated escape reflex in fish involves a somewhat complex circuit, with no single neuron necessary to evoke the escape reflex (Liu and Fetcho, 1999). In their recent *Journal of Neuroscience* article, Gahtan et al. (2005) (http://www.jneurosci.org/cgi/content/full/25/40/9294) present research that has uncovered a putative small neural circuit that is responsible for visually mediated prey-capture behaviors in larval zebrafish.

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Zebrafish prey capture is a visually driven behavior involving fine axial motor control (Borla et al., 2002). The authors performed several experiments to further examine this behavior. Ablations of the optic tectum resulted in impaired prey-capture ability [Gahtan et al. (2005), their Fig. 2 (http://www.jneurosci.org/cgi/content/full/25/40/9294/FIG2)], consistent with a primary role for vision in prey capture. In addition, both wild-type zebrafish tested in dark conditions and blind *lakritz* mutants had reduced rates of success in prey capture relative to wild-type fish.

The optic tectum (homolog of the superior colliculus) processes much of the incoming visual information in lower vertebrates. To drive prey-capture behaviors, visual neurons in the tectum must project to premotor areas of the brain. Although tectal cells do not project directly to the spinal cord, they project to reticulospinal neurons. Gahtan et al. singled out reticulospinal neurons in the nucleus of the medial longitudinal fascicle (nMLF) for additional investigation because they had not been examined previously in prey capture. The dendrites of two pairs of neurons in the nMLF, MeLr and MeLc neurons, ramify within the putative output layers of the tectum [Gahtan et al. (2005), their Fig. 3 (http://www.jneurosci.org/cgi/content/full/25/40/9294/FIG3)] and are thus in a position to relay visual signals to the spinal cord.

The role of the MeL neurons in visually mediated prey capture was tested by ablating groups of neurons in the visual pathway. Ablation of MeLr and MeLc selectively impaired prey capture, evidenced by a reduction in prey (paramecia) capture within a 5 h window. Combinations of MeL ablations and tectal ablations were performed as well. Ipsilateral-only ablations (tectum plus ipsilateral MeL), which leave the contralateral pathway intact, impaired prey capture somewhat. However, much larger deficits were seen with contralateral ablations (tectum plus contralateral MeL), which eliminate one obligate neural element on each side [Gahtan et al. (2005), their Fig. 4 (http://www.jneurosci.org/cgi/content/full/25/40/9294/FIG4)]. Control ablations of a randomly selected group of four identified reticulospinal neurons did not impair prey capture.

Prey capture represents a set of behaviors, involving prey recognition, orienting and swimming toward the prey, and a culminating strike. These behaviors may have different neuronal substrates. Therefore, the authors used high-speed video to determine which specific behavior was affected by the MeL ablations. The data suggested that the fish with MeL ablations were unable to orient toward the prey. Control experiments revealed no differences in optokinetic reflexes between normal and MeL-ablated fish [Gahtan et al. (2005), their Fig. 6 (http://www.jneurosci.org/cgi/content/full/25/40/9294/FIG6)], suggesting that the lesions did not affect oculomotor control.

The authors have provided strong evidence for a neural pathway involved in visually mediated prey capture. The MeL neurons represent a point at which visual information is transmitted to the motor system to generate an appropriate response to the stimuli. This raises several interesting questions. For instance, do MeL neurons directly control the orienting response, or do they act as a "command releasing system" (Ewert, 1987) that activates downstream neurons to generate the muscular activity required for orienting toward prey? Do other neurons in the nMLF (or elsewhere) function in a similar role to the MeL neurons but for different stimuli and behaviors? Finally, is the system architecture conserved across vertebrates and therefore a fundamental anatomical substrate for simple reactive behaviors? Future studies may be able to address these questions, advancing our understanding of how sensory information is processed to yield appropriate contextual behaviors.

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