Spitting and Gulping: Opposite Feeding Behaviors Produced by the Graded Activity of a Single Pharyngeal Neuron

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How animal nervous systems generate context-appropriate behaviors is an important problem in neuroscience. To study this problem, we are analyzing how the *C. elegans* pharynx, which in the wild encounters potential food ranging from nutritious to harmful, changes its rhythmic pumping motions to adapt feeding behavior to the environment.

We previously found that noxious stimuli induce spitting of food via the M1 pharyngeal neuron (Bhatla *et al.*, 2015). While feeding pumps retain food, spitting pumps eject food back into the environment by opening a valve at the front of the pharynx.

Here we report a novel pharyngeal behavior, gulping. In normal feeding, the metastomal flaps of the anterior pharynx are partially closed, reducing the rate of ingestion (Fang-Yen *et al.*, 2009). In gulping, these flaps are open, allowing enhanced ingestion. Intriguingly, the flaps are innervated solely by M1 and also open during spitting, suggesting that M1 might control both particle influx (via the flaps) and particle efflux (via the valve). In support of this hypothesis, we found that weak M1 activation promotes gulping (i.e., flaps open, valve closed) and strong M1 activation promotes spitting (i.e., flaps open, valve open). Thus, M1 appears to produce opposite spitting and gulping behaviors in a graded way, based on its level of excitation. A consequence of positioning these behaviors adjacently in M1 activity-space is that engaging in gulping inherently brings worms closer to spitting, a feature that might mitigate the potential risk gulping worms face of too rapidly ingesting toxins, pathogens, or non-food particles.