Tasting Light: A *C. elegans* Pharyngeal Neuron Senses the Hydrogen Peroxide Produced by Light To Directly Relax Pharyngeal Muscle

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Organisms use specific proteins to sense light, such as rhodopsin, phytochrome, xanthopsin, cryptochrome, phototropin and BLUF sensors. *C. elegans* appears to use a novel protein: the worm's avoidance of shortwave light requires LITE-1, a homolog of *Drosophila* gustatory GPCRs (Edwards..Miller 2008). We found that light immediately inhibits pharyngeal pumping. This inhibition is partially independent of *lite-1*, indicating that a second light-sensing mechanism functions in the worm.

Through systematic laser ablation of pharyngeal neurons we found that ablation of the I2 neuron increases the time it takes for light to inhibit pumping. Furthermore, light rapidly increases I2 calcium. I2 calcium increases even in *unc-13* mutants defective for synaptic signaling, suggesting that I2 might directly sense light.

Two I2-expressed genes are required for both the rapid inhibition of pumping and the increase in I2 calcium: *gur-3,* a *lite-1* paralog, and *prdx-2*, a peroxiredoxin. Since peroxiredoxins are antioxidants, we tested the effect of hydrogen peroxide (H_2O_2) on pumping. Like light, H_2O_2 odor elicits both avoidance and pumping inhibition. H_2O_2 odor and light act through the same mechanism to inhibit pumping, as both depend on *gur-3* and *prdx-2*. *lite-1* is also required for H_2O_2 avoidance, and the *lite-1 gur-3* double mutant is completely defective in the pumping response to H_2O_2, just like with light.

One possibility is that light produces H_2O_2. H_2O_2 can be detected by the generation of Prussian blue (Saito..Yoshida 2007), and we found that shortwave light also generates Prussian blue in water, likely through the production of H_2O_2 (as addition of catalase reduces pigment formation).

Downstream of *gur-3* and *prdx-2*, *eat-4*, a vesicular glutamate transporter, functions in I2 to inhibit pumping, suggesting that I2 releases glutamate in response to light/H_2O_2. A glutamate-gated chloride channel, *avr-15*, functions in the pharyngeal muscle to inhibit contractions in response to light/H_2O_2.

Overall, these results suggest that light produces H_2O_2, either in the water around the worm or within the worm itself. The I2 neuron senses this H_2O_2 via *gur-3* and *prdx-2* and releases glutamate to directly inhibit muscle via the *avr-15* receptor. Sensing light via an H_2O_2 intermediary suggests that light-sensing in the worm might have evolved from a pre-existing H_2O_2 avoidance mechanism.

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