one of the 43 glomeruli in the antennal lobe to fluoresce—the V glomerulus (**Fig. 1**).

Previous work[7] had identified a population of olfactory receptor neurons expressing one single olfactory receptor type, G21A, all located in the appropriate portion of the antenna for sensing CO_2, and had noted that these ORNs all projected to the V glomerulus. In *Drosophila* it is possible to genetically engineer temperature-dependent inactivation only of these ORNs. To do so, the authors used the G21A promoter and the binary Gal4 system for tissue-specific expression[8], and the Shibire^{ts} gene, which encodes a dominant mutant dynamin protein that prevents transmitter release at elevated temperature[9]. These mutant flies failed to avoid CO_2 at high temperature, suggesting that G21A is the molecular receptor, perhaps the sole receptor for CO_2. This selective neuronal blockade, however, did not abolish the flies' response to the complete stress odor. Suh *et al.* are notably coy about stating whether or not information about the other components of the stress odor is routed through the V glomerulus.

Where does the olfactory information go from here? What higher centers in the brain mediate the avoidance response? Not the mushroom bodies, brain structures that are necessary for learned olfactory avoidance. Eliminating these brain structures by hydroxyurea treatment during development[10] or silencing them with tissue-specific expression of Shibire^{ts} had no effect on avoidance, although these authors and many others have found both treatments disrupt learning. This leaves the lateral protocerebrum as the prime (but not the only) suspect in the innate avoidance response. The issue of circuitry is of more than Drosophilosophical interest, because *Drosophila* olfactory learning involves a conditioned avoidance response to an experimentally selected odor, behaviorally similar or identical to the innate avoidance response studied here. Thus it is likely that the innate and learned pathways re-converge on the same pre-motor center or centers, which then elicit the stereotyped avoidance behavior. How such a behavioral circuit might branch through a learning center and re-converge is a general question, because classical conditioning studies since Pavlov have concentrated on modulating an existing, innate behavior or 'reflex'.

The way to find the next brain area in the innate pathway is with tissue-specific inactivation of brain structures using Shibire^{ts} or, better, with mutants. The authors indicate that they have started the first approach, using an available, randomly created library of Gal4 enhancer traps to selectively express Shibire^{ts} in various brain regions and thereby alter behavior. They report on one line, c761, which has substantially reduced avoidance to both CO_2 and the complete stress odor, and an expression pattern principally in the V glomerulus. This is a satisfying start, but still a small foot in a big door. In the long run, though, this defined behavior and defined anatomical system, together with sophisticated *Drosophila* technology plus a series of mutants, should help decipher the general problem of olfactory coding in the glomeruli and higher brain. It is an old and Gordian problem, but others just as daunting have been solved in this way.

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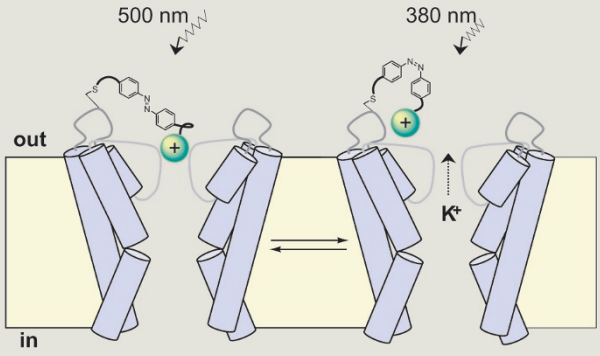
A MOLECULAR LIGHT SWITCH TURNS OFF NEURAL ACTIVITY

From single-cell recordings to whole-brain imaging, many current techniques allow scientists to monitor neural activity. However, testing the causal relationships between individual circuits and their proposed functions will require better tools to perturb cellular activity selectively. In a Technical Report on page 1381 of this issue, Richard Kramer and colleagues describe the use of a photoisomerizable ligand for rapid, reversible and spatially precise remote control of neural activity. Previous attempts to selectively manipulate activity in a particular set of neurons have been limited by inadequate temporal and spatial control. By engineering SPARK (synthetic photoisomerizable azobenzene-regulated K) channels that can be precisely and reversibly activated by light, Kramer and colleagues have overcome these limitations.



Voltage-gated potassium channels can be blocked by quaternary ammonium (QA) ions that bind to amino acids in the pore-lining region. Kramer and colleagues synthesized a tether attached to a QA group, which can covalently bind to a potassium channel that the authors modified to make the QA blocker the primary determinant of its gating. A section of the tether is photoisomerizable, meaning that its conformation can be changed by light. Shining light of a long wavelength (500 nm) shifts the tether into a long form, whereas light of a shorter wavelength (380 nm) shifts it to a shorter form. In the long form, the attached QA group can access and block the potassium channel pore, turning the channel off, but in the short form, the QA group does not reach the channel, allowing potassium ions to flow out of the cell. Because potassium efflux causes neurons to become hyperpolarized, the short-wavelength light can silence activity in hippocampal neurons exogenously expressing the SPARK channels. This new technique should find wide applicability in studies of circuit function and in other manipulations of neuronal activity. In addition, it should spark the development of more experimental, and perhaps therapeutic, tools.

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