Summary

The *Gr21a* gene belongs to the family of *Drosophila* gustatory receptor genes. However, we show that it is expressed in ab1C neurons in the antenna, and has an olfactory role. These neurons are specifically tuned to the ubiquitous gas CO_2 and are sensitive to concentrations close to those in ambient air. A linear relationship exists between calcium signals in these neurons and their action potential firing rates. Increases in intracellular calcium are found to be similar, whether measured in the antenna or in the axonal endings that converge onto a single glomerulus in the brain. Behaviorally, the flies avoid CO_2. We quantify the relationship between excitation levels of ab1C neurons and the avoidance response. *Gr21a*-driven ablation of ab1C neurons severely affects this response. Our results introduce a special pathway within the olfactory system of *Drosophila* that might work according to non-combinatorial principles