Manipulating Senses

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TASTE AVERSION

Can naive predators be taught to avoid consuming a lethal prey? That's the question three University of Sydney ecologists recently attempted to answer. Stephanie O'Donnell, Jonathan Webb, and Richard Shine published their proof-of-concept study online on 14 April in the *Journal of Applied Ecology*.

The northern quoll (*Dasyurus hallucatus*), a cat-sized marsupial with a penchant for frogs, has been hit hard by the spread of an invasive toad with poisonous glands. As populations of toxic cane toads (*Bufo marinus*) increase, quoll numbers have dropped so precipitously that the species is now listed as endangered. These large, fecund amphibians, introduced to Australia in 1935 to control sugar cane pests, produce toxins at every life stage, killing most of the aquatic and terrestrial creatures that try to devour them. So far, individuals from 27 native Australian species, as well as domestic pets and even humans, are known to have died after mouthing or ingesting the toad, its eggs, or its tadpoles.

For the conditioned taste-aversion study, 62 young quolls from a captive breeding program were split into two groups, and half—the "toad-smart" group—were given dead cane toads laced with an emetic. All the quolls were radio-collared, and before their reintroduction to the wild they were shown live cane toads to gauge their responses—a wise move, since a few of the quolls escaped detection once they were released.

"Toad-naive" male quolls were quick to go after cane toads, and they had the worst apparent survival rate (58 percent). Toad-naive females did almost as well (84 percent) as the toad-smart males (88 percent), and toad-smart females were best at avoiding death by cane toad ingestion (94 percent) over the 10-day study period.

Where will this lead? One possibility suggested by the authors is aerial deployment of "toad baits" ahead of the cane toad invasion front, which would presumably teach quolls to avoid live toads once they arrive. An alternative strategy would be to incorporate toad-bait training into existing mark-and-recapture monitoring programs.

"This is remarkably clever science," says Bill Laurance, of James Cook University. "The cane toad is having a devastating impact on some native predators in Australia, and this well-designed and -implemented study seems to provide a viable strategy for reducing toad impacts on a sensitive species.

"The sad bit," he adds, "is the extreme and expensive measures one has to take to limit the damage from the worst invasive species, such as the cane toad. The only real strategy is to prevent or quickly stamp out such invasions in the first place."

BLOCKING SCENT CUES

Can the senses animals use in their hunt for food, such as smell, be manipulated? The answer is yes, according to University of California, Riverside, entomologists whose exciting new research may have implications for preventing mosquitoes from detecting humans. The groundbreaking study by Stephanie Turner and Anandasankar Ray appeared in the 10 September 2009 issue of *Nature*.

Insects use carbon dioxide (CO_2) as a cue for a number of behaviors. Fruit flies (*Drosophila melanogaster*) detect CO_2 in the odor emitted when nearby flies are stressed and fly in the opposite direction. Flies are also attracted to odors emitted by ripe fruit, which contain CO_2. How do flies know when to fly toward a source of CO_2 to feast, and when to flee from a CO_2 distress signal? Turner and Ray found that a couple of compounds, or odorants, emitted by overripe fruit turn off *Drosophila*'s ability to detect CO_2.

The scientists screened a battery of odorants by measuring their ability to inhibit the electrophysiological response of a single olfactory receptor neuron sensitive to CO_2. Two inhibitory odorants, hexanol and 2,3-butanedione, were found to block a response to CO_2.

These compounds were then evaluated in a series of T-maze tests to measure their effectiveness at blocking *Drosophila*'s avoidance of stress odor or CO_2: 2,3-butanedione completely blocked CO_2 avoidance behavior in the fly. In addition, the effect with 2,3-butanedione lasts well after the odorant is gone.

The CO_2 receptors in fruit flies are nearly identical to those in many insect species, including mosquitoes, which are highly attracted to CO_2 from exhaled air. In the current study, the CO_2-sensing neuron in mosquitoes was also used to screen odorants, and two, butanal and hexanol, were found to inhibit an electrophysiological response to CO_2. This finding may be the basis for an important new line of defense against mosquitoes and mosquito-borne diseases.

DIGITIZING SMELL

Can one know in advance the likely gustatory or olfactory properties of molecules? Recent research appearing in the April 2010 issue of *PLoS Computational Biology* indicates this may be possible, despite the widespread view that smell is subjective and rooted in culture.

Scientists at the Weizmann Institute, in Rehovot, Israel, tuned an electronic nose, or eNose, to the perceptual pleasantness of odorants, and then tested its ability to predict whether novel odorants would be pleasant to humans. They compared the eNose's pleasantness ratings of unknown odorants with ratings made by human subjects from different (Israeli and Ethiopian) cultures. The eNose demonstrated 82-percent similarity to human perception—a promising proof of concept that may lead in a variety of directions.

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