

Brainiac BY KEVIN HARTNETT

Virtual odor environments

FOR HUMAN BEINGS, smell is a nice if somewhat auxiliary sense. In many corners of the animal kingdom, though, it's the essential way organisms understand the world.

"For most animals, if you lose your sense of smell, you're done," says John Crimaldi, who studies environmental fluid mechanics at the University of Colorado Boulder. "For us, it's harder to have a good intuitive sense of it, because we don't rely on that sense as heavily as some creatures."

Crimaldi is among a group of researchers from a range of fields that has recently started work on an ambitious project to establish how olfactory perception works. The effort, which is part of the White House BRAIN Initiative, seeks to map the way organisms respond behaviorally to odors and nail down the neural pathways that undergird those responses.

"[Olfactory navigation] is something animals are really good at and we engineers are not good at," says Katherine Nagel, a neuroscientist at the New York University School of Medicine who will be conducting experiments on flies and their sense of smell. "We don't know how to build a robot that finds a gas leak, but if you leave a piece of fruit out on the table, flies will be there in the morning."

The project, which got underway late last year, involves a number of different kinds of experiments. Several involve positioning mice or flies in a "virtual odor environment," similar to the virtual reality environments generated by devices like Oculus Rift — except in these, the visual and sound

stimuli are replaced with precisely controlled odors.

"Instead of visual projectors providing visual information into the right and left eye, we have olfactometers that release puffs of odorant into the right and left nostrils," says Crimaldi. "The animal perceives something that's entirely realistic, and we know exactly what it's smelling because we're providing that information."

To create these virtual odor environments, the researchers first have to understand the physics of odor plumes. Crimaldi is doing this in his laboratory, where he releases chemical compounds into a controlled air or water environment and shines a laser on them. The laser reveals the internal spatial patterns of an odor plume and allows his lab to track how those patterns change as the plume moves away from the source and diffuses in the environment. You might imagine the plume as a stream, spreading out evenly from a center line, but the actual spatial arrangement is much more complicated — with strands of odor here, dense knots of odor there, and many empty pockets where there's no odor at all.

"When you have this odor plume and it's being transported by a moving body of air, that moving body of air is almost universally turbulent, and the patterns that develop in the odor plumes as you move downstream become very complex," says Crimaldi. "It's very intermittent and episodic, and there are lots of places where there's no odorant and other places where there are strong, intense filaments of odor."

Knowing the physics of odor plumes lets the researchers do two things. First, it allows them to create the virtual odor environments. Second, it allows them to begin to think about the kinds of information animals might extract from an odor plume in order to decide how to behave. Given that following an

odor trail (or escaping from one, as animals do when they sense a predator) is not as simple as running on a line, the researchers want to know what animals can calculate about the location of an odor source from the complex composition of the odor plume at any given point in space.

"There are all sorts of statistics we can show that are different at this location [in the odor plume] than that location, but we don't know that those are the statistics the animals are using," says Crimaldi. "We're pretty confident there's information in there, but we can't a priori say which ones the animals are making use of."

As the mice and flies navigate the virtual odor environments, researchers track their behavior and try to create a general view of how animals make decisions based on olfactory stimuli.

"The idea is we try to understand how the behavior relates to each animal and the animal's abilities and then generate a model that will predict [behavior] for other animals we haven't tested," says Justus Verhagen, a neuroscientist at the Yale School of Medicine and researcher on the project.

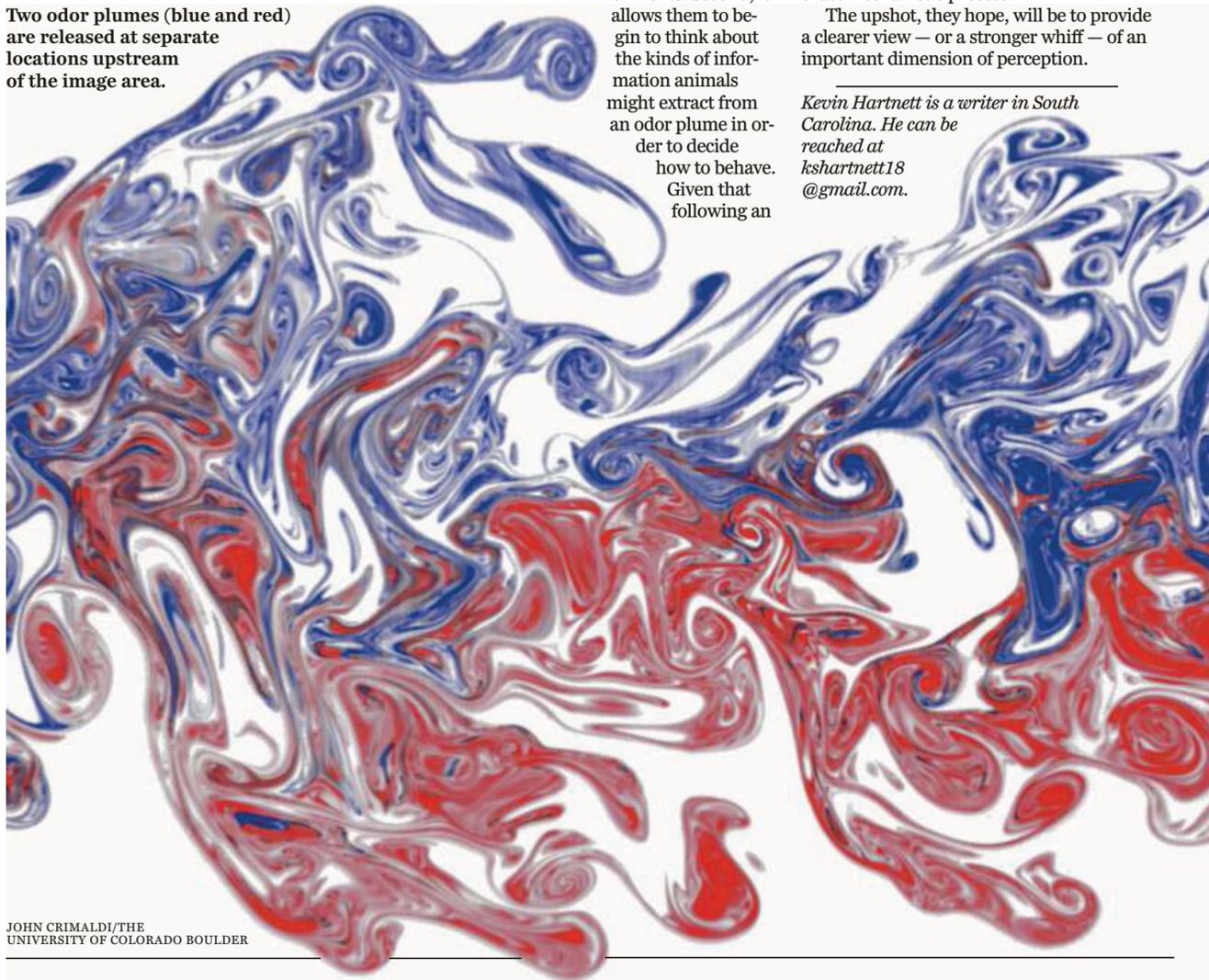
At the same time the researchers track behavior, they'll also be observing the brain neurons that fire in conjunction with the behavior. By doing this, they'll try to understand not only what animals do based on olfaction but also the exact neural infrastructure that makes such highly developed behavior possible.

"We want to replicate the physical neural network that actually exists in the brain," says Crimaldi. "We want to do it the way the rat's brain does it, not just to get the same end result, but to understand the exact mechanistic process."

The upshot, they hope, will be to provide a clearer view — or a stronger whiff — of an important dimension of perception.

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Two odor plumes (blue and red) are released at separate locations upstream of the image area.



JOHN CRIMALDI/THE UNIVERSITY OF COLORADO BOULDER

OPINION EMILY MOSS

A better way to honor Dr. King

A little more than 30 years ago, Congress established a national holiday celebrating Martin Luther King Jr. and his fight against racial segregation. Most students today like the holiday because it means a day off from school. I'm not sure King himself would have been ready to celebrate, and I doubt he would have approved of giving a day off from school in his name. Maybe there's a better way to honor his memory by erasing lines that continue to divide us, even if only for just a day.

When King was a child, black students in the South were forced by law to attend racially segregated schools. King called this the "walling off of Negroes from equal education." Fortunately that's not true anymore. Legal segregation is a thing of the past. Yet it's obvious to virtually everyone that urban and suburban school districts are effectively segregated once again, not by law but in other ways, including by family income. Even within schools, students are divided (some might say segregated) into separate educational "tracks," which label them as average or advanced. I've witnessed this division firsthand, both as a student and as a tutor, and I've come to believe that the best way to honor Martin Luther King Jr. would be for all of us to do what we can to break down these barriers — including right here in Massachusetts.

I began to think hard about this problem when I started tutoring at a Boston public school, where, according to the Massachusetts Department of Education, roughly two-thirds of students come from low-income families — a profile that's radically different from most of the nearby suburbs. The kids at the Boston

accomplish." That's not to suggest a need to get rid of tracking altogether, but all students should have the chance to work together in untracked classes for at least part of every day.

Our schools should also help bring students together across district lines. Newton high school students participate in exchange pro-

In Newton, where I live, it's tempting to dismiss educational inequality as someone else's problem.

school where I've tutored are highly motivated, but they face all sorts of challenges. They also face a tracking system that divides them into separate classrooms as early as fourth grade, leaving many feeling discouraged.

In Newton, where I live, it's tempting to dismiss educational inequality as someone else's problem. But it's our problem, too. Newton schools also track far more than they should. By separating students into different levels, we create barriers that can divide and weaken us. How can we all learn from one another if we're in different tracked classrooms? Sal Khan, the founder of the online educational service Khan Academy, calls tracking "a process of exclusion, which is exactly the opposite of what our schools should be trying to

grams all over the world, but most have never visited a Boston public school just 20 or 30 minutes away. It's as if these Boston schools are walled off, strangely more foreign than the other nations we visit. And the suburban schools are similarly walled off from most of the Boston kids. It's time to break down these walls.

One potential starting point: a daylong exchange program across Boston and suburban schools, so that students from different neighborhoods could come together. And why not hold such an exchange on Martin Luther King Day? It would be a fitting tribute.

Emily Moss is a junior at Newton North High School.

Uncommon Knowledge

Surprising insights from the social sciences BY

KEVIN LEWIS

Your neighborhood becomes you

MARTIN LUTHER KING JR. dreamed that people would "not be judged by the color of their skin but by the content of their character." Well, here's some good news — sort of. Racial stereotypes may be largely driven by assumptions about the content of one's neighborhood, rather than assumptions about innate racial differences. Psychologists at Arizona State University found that both black and white residents of poor neighborhoods — even if they were personally not poor — were stereotyped as impulsive, opportunistic, less invested in education and their children, and promiscuous. In fact, there were no statistically significant differences in these stereotypes between white and black residents of poor neighborhoods, or between white and black residents of affluent neighborhoods.

Williams, K. et al., "Ecology-Driven Stereotypes Override Race Stereotypes," Proceedings of the National Academy of Sciences (forthcoming).



SHUTTERSTOCK

If asked, do tell

IF YOU'RE TRYING to get hired or get a date, think twice about choosing not to answer. Researchers at Harvard Business School found that potential dates or employees who disclosed negative information were preferred over those who selected the "choose not to answer" option. This was true even in egregious cases: "64 percent of participants preferred to date the revealer — the person who had admitted to frequently hiding sexually transmitted diseases from dating partners — to a hider who had chosen not to answer that question." Likewise, when presented with job candidates who had been asked about their lowest final-exam grade, people overwhelmingly preferred to hire the candidate who reported an "F" compared with the candidate who chose not to answer, even though people assumed the former had gotten a lower score. This effect was explained by revealers being perceived as more trustworthy.

John, L. et al., "Hiding Personal Information Reveals the Worst," Proceedings of the National Academy of Sciences (forthcoming).

Out of line

HOW SQUARE ARE conservatives? New research suggests that conservatives are less likely than liberals to judge an imperfect shape — for example, a square with a missing or bent segment — as representative of that shape. In other words, conservatives are less accepting of deviance in all its forms. This was not explained by differences in moral attitudes or ambiguity aversion. Ideological sensitivity to (shape) deviance partly explained the relationship between ideology and support for welfare spending, punishment judgments, and policies related to deviant groups.

Okimoto, T. & Gromet, D., "Differences in Sensitivity to Deviance Partly Explain Ideological Divides in Social Policy Support," Journal of Personality and Social Psychology (forthcoming).

Downloading division

THERE ARE MANY partisan websites out there, but to see them in all of their glory, you need a decent broadband Internet connection. Could that mean that broadband is contributing to partisan polarization? A study found that areas with less restrictive right-of-way regulation or more favorable topography — and thus more broadband infrastructure — had more partisan animus. In addition, individuals with broadband (vs. dial up) were more likely to visit partisan websites, even controlling for demographic factors.

Lelkes, Y. et al., "The Hostile Audience: The Effect of Access to Broadband Internet on Partisan Affect," American Journal of Political Science (forthcoming).

Headstrong

RESEARCH HAS SHOWN that the theoretical benefit of safety equipment can be much lower in reality because users feel more comfortable taking greater risks. In a new experiment, psychologists found that this effect may be even more deeply ingrained than we think. Participants were told the experiment was an eye-tracking study and donned an eye-tracking device that was fitted to either a baseball cap or a bicycle helmet. The whole eye-tracking thing was just a cover though to see how participants reacted to wearing the cap or the helmet. Participants wearing the helmet took more risks in a computer game and reported more interest in thrills and new experiences. This effect was not modified by actual bicycling experience.

Gamble, T. & Walker, I., "Wearing a Bicycle Helmet Can Increase Risk Taking and Sensation Seeking in Adults," Psychological Science (forthcoming).

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