

Scope



RESEARCH AT NEW YORK UNIVERSITY

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Breaking Bad

NYU climate scientists
are braving the elements
to study the catastrophic
link between disintegrating
ice and rising seas



REMOTE
WORK

What does it take to set up camp in some of the most inhospitable places on Earth? Find out in our cover story on page 18.

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Illustration by Zakiya Noel

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ZOOM IN

MAKING A MEND

The human genome is under constant siege from natural factors and external agents, such as UV rays or tobacco smoke. Luckily, our cells normally mend damaged DNA, but when they don't, potential consequences include cell death or disease. Now scientists have identified how the damaged molecules are repaired, after analyzing more than 20,000 DNA breaks in over 600 cells. The team, led by physics professor Alexandra Zidovska, found that DNA around breaks undergoing repair are packed more densely than the surrounding healthy DNA and move faster too. Zidovska believes this better understanding of the human genome's fix-it process may "offer a pathway for enhancing cancer diagnosis and therapy."

Distillations

Scope
2022



Hope Probe to Mars: Anyone There?

Who's your favorite Martian? "Never ask a scientist that," jokes Dimitra Atri, an astrophysicist who co-leads the Mars Research Group at NYU Abu Dhabi's Center for Space Science. None of the literary, film, and TV representations—from Ray Bradbury's yellow-eyed extraterrestrials to the eggheaded creatures of *Mars Attacks!* to H. G. Wells's tentacled terrors—hold a candle to the microbial life Atri hopes might someday be found with the help of data collected by the Emirates Mars Mission Hope Probe. Inserted into Martian orbit in February 2021 where it will collect data for a single Mars year (that's about two years to you Earthlings), the probe offers the most complete picture yet of the Red Planet's atmosphere and will add to the extremely limited data on exoplanets too. "The question is, are any of the thousands and

thousands of planets beyond the solar system habitable?" says Atri. "The best place to explore this is Mars because [4 billion years ago] it was very, very Earth-like, and there's a high possibility that maybe some kind of microbial life still exists somewhere below the surface, maybe in its polar regions." Once (relatively) balmy, the Red Planet is now "a cold and dry place with hardly any atmosphere," says Atri, and lessons learned about its evolution, including the impact of solar radiation, could be applied to keep Earth from meeting the same fate one day. And because Mars lacks the Earth's tectonic activity, it's beautifully preserved. "You can find things 4 billion years old right there on its surface," says Atri. "You have this full museum, a full record of an entire solar system right in front of you. That's why it is so exciting." —*Dulcy Israel*

ProPic/Getty Images; opposite page: Westend61/Getty

Addicted to Like

WATCH YOUR MOUTH

Dental detectives have found that older adults with off-kilter oral microbiomes are more likely to have amyloid beta in their cerebrospinal fluid, a biomarker for Alzheimer's. The study, says NYU Dentistry's Angela Kamer, highlights not only the "role of 'bad' bacteria but also 'good' bacteria in modulating amyloid levels." Seventy percent of adults 65 and up suffer from periodontal disease, which causes chronic inflammation and bacteria-harboring pockets around teeth. The team will next investigate if deep cleanings can help avert Alzheimer's.

Post. Refresh. Count likes. Post. Refresh. Count likes. This could go on all day. And since we're talking about social media here, it sometimes *does* go on all day. This human behavior bears a resemblance to that of lab rats in a Skinner box clicking levers to release a little food, according to a study co-led by David Amodio, professor of psychology and neural science. "Internet use is often described as an addiction or conditioned response, like rats in a cage," he says. "Although it's a caricature, it led us to wonder if people's online posting behavior might actually resemble a mechanism of reward-reinforcement learning, [which] had never been tested."

So the researchers fired up

Instagram and analyzed more than 1 million posts by more than 4,000 users, focusing on the timing and cadence of posting and how it correlated to rewards (hearts and likes, of course). A pattern emerged: the frequency with which someone posts directly corresponds to the number of likes their posts get. "This form of learning is associated with dopaminergic pathways involving the striatum, a part of the brain that supports reward processing and goal-driven behavior in all aspects of human behavior," he says. "Our findings add to the growing understanding of how social media platforms like Instagram affect people—how they draw them in and keep them posting."

The team published their work months before a whistleblower leaked internal findings from Facebook that its Instagram app contributes to higher levels of anxiety and depression among young people, as well as body image issues for teenage girls. "Other research has found that teens and adolescents are especially sensitive to reward learning," says Amodio. "And due to their still-developing prefrontal cortex, they are less adept at self-regulation. This combination of factors may help explain why they are particularly vulnerable to the effects of social media." His hope is that rooting such behavior in models of reward learning may yield new therapeutic approaches. —Rory Evans



Illustration by Dan Page

BIRTH RIGHTS

Providing quality care during the childbirth process is not just about tending to the physical. It's also "an act of respect and regard," says P. Mimi Niles, a midwife and assistant professor at the Rory Meyers College of Nursing. Niles's study of pregnant women found that those who declined recommended treatments such as prenatal testing or an induction were often coerced, manipulated, and dismissed—which can impact self-efficacy, mental health, and a willingness to interact with future healthcare. "How we provide care is just as important as *what* care we provide," she says.



Drawing Strength from Art

Over the course of three-plus years, five groups of people with Parkinson's disease, most with stage 2 or 3 of the condition, gathered at NYU to splash watercolors, rub pastels, mold clay, and manipulate other media for 90 minutes twice a week. Before and after each of the 10-week sessions, art therapists and doctors examined the volunteers and their artwork to assess the rehabilitative potential of art therapy for people with Parkinson's. The project—ExplorArtPD—was a unique collaboration between Steinhardt's Art Therapy program and the Marlene and Paolo Fresco Institute for Parkinson's and Movement Disorders at NYU Langone Health. The results were remarkable. "The composition of the artwork was more integrated and the environ-

ment was richer, while the [earlier work was] more isolated and empty," says Ikuko Acosta, director of the graduate Art Therapy program and clinical associate professor at Steinhardt. Using brain imaging, eye tracking, gait testing, and more, the Langone investigators found considerable improvement in motor skills, visuospatial function, brain connectivity, and other functions. Acosta hopes her team's current work with people with multiple sclerosis will prompt the same profound effects. "Before, [the Parkinson's participants] were kind of giving up," she says, "but there are many little ways the creative ground of art therapy is improving the basic quality of their everyday life. We didn't expect that." —D. I.

Illustration by Eva Vázquez

Biggest Brewery This Side of the Nile

Think about the history of beer, and Bavarians in lederhosen swilling from steins might spring to mind. But thousands of years before the advent of Oktoberfest, beer played a central role in ancient Egypt. That fact was recently underscored when archaeologists unearthed the ruins of a massive brewery, dating from about 3000 BCE, at the site of the ancient city of Abydos. The discovery is the first proof that inhabitants of the Nile Valley brewed quantities comparable to modern commercial operations. “This was really industrial-scale production on a level that wasn’t happening anywhere else in the world,” says Matthew Adams, senior research scholar at NYU’s Institute of Fine Arts and director of the Abydos project. The findings demonstrate that Egyptian kings of that era had “an ability to marshal labor and mobilize resources, as well as serious administrative, organizational, and logistical capacity,” says Adams, “and that is what allowed them to build the pyramids just a couple of centuries later.”

BOTTOMS UP

For ancient Egyptians, drinking beer was about more than just a good time. “Beer was an absolute staple and part of their basic subsistence,” says Adams. “Wages were paid first and foremost in foodstuffs, and the most basic ones were bread and beer.” And home brewing wasn’t only for hipsters: “Every family made their own beer, on a household level.”

SOME SERIOUS SUDS

Though not the oldest, the Abydos brewery is by far the largest. “The scale of production is staggering. We’re talking about more than 20,000 liters of beer per batch, which equates to around 40,000 pints,” says Adams. “That’s enough to give a pint of beer to every person in a professional sports stadium. And they could probably do a batch every week, adding up to more than a million liters per year.”

NECTAR OF THE GODS

So who was guzzling all that booze? Possibly no one. Abydos was home to the tombs and funerary temples of Egypt’s first kings, and evidence suggests the beer was used in ceremonies dedicated to those deceased rulers, who were considered gods. “Worshipping meant presenting the dead with offerings, which they believed the person would come and partake of to sustain them in the next

world,” says Adams. “Offering food or beer was the most fundamental aspect of religious performance.”

STRANGE BREW

Like some modern varieties, the beer produced at Abydos was made from fermented wheat, but it would have tasted quite different from ours. “The Egyptians didn’t have hops, which are almost universal in beer today and provide that characteristic crisp, bitter flavor,” says Adams. “In comparison, Egyptian beer would have seemed almost sweet and, because the Egyptians didn’t have the filtration technology we have, it would have been very cloudy, with a certain amount of particulate content. That also

gave it a higher nutritive value.”

MORE ON TAP

The team plans to return to Abydos, aided by specialists. “A paleobotanist will be doing detailed analysis of the beer residues to try to work out its composition and chemistry, and we’re collaborating with beer scientists from the Technical University of Munich,” says Adams. “The project brings archaeology solidly into the hard sciences—biology, biochemistry, DNA analysis—and represents a high level of global collaboration. Almost everyone can identify with beer, so if we’re successful in everything we want to do, the end results will make a big splash.” —*Jenny Comita*



Illustration by Davide Bonazzi

FREED SPEECH

Don’t judge NYU Steinhardt assistant professor Eric Jackson too harshly for attempting to make the subjects of his study feel completely and utterly alone. That’s how he was able to confirm anecdotal evidence that people who stutter don’t do so if they think no one’s listening. “We developed a novel method to convince participants that their speech wouldn’t be heard,” says Jackson, whose *Journal of Fluency Disorders* study explores how social pressure may influence stuttering. His team analyzed adult stutterers under five different conditions: in four of the paradigms, the participants were required to speak knowing they had an audience, but in the fifth, they were tricked into believing that no one would hear them. They were then asked to complete a difficult computer programming task that’s known to elicit private talk. The frequency of stuttering in the first four scenarios was similar, but in the fifth, stuttering was not observed in more than 10,000 syllables except for seven possible mild stuttering events from three subjects. Demonstrating that the “talk alone effect” is real, Jackson says, “provides evidence that stuttering isn’t just a speech motor system issue, but that at its core there must be a strong social component.” —*D. I.*



Tending to Farmers of Color

America’s deplorable history of yanking land, liberty, and livelihood out from under Black citizens extends to Black farmers, whose numbers have dwindled from nearly a million a century ago to about 45,000 today. In addition to being physically forced off their land through acts of domestic terror, Black growers are systematically denied the USDA subsidies and loans sustaining their White counterparts—who own more than 90 percent of the nation’s farms. Knowing who’d be hardest hit when the pandemic triggered an economic crisis and exacerbated food insecurity, Kaia Shivers created the Black Farmers Index.

“I wanted to offer a solution [that allows] people to directly contact farmers and buy their produce, their meat, and whatever it is that they harvest or raise,” says Shivers, Liberal Studies clinical assistant professor and founder of the online news agency Ark Republic. The free directory lists more than a thousand Black farmers and is especially welcome as promises of debt relief through the Biden administration’s American Rescue Plan fade in the face of political and legal roadblocks. Shivers also publishes a biweekly newsletter, offers marketing tips, and very occasionally connects busy farmers with a potential big purchase. “We don’t like to be the middle people,” she says, “[because] we really want folks to have relationships with the people who grow their food.” —*D. I.*

instamatics/iStock

HIDE-AND-SEEK FOR SCIENCE

Lemurs get a bad rap. “They’re considered the dumb primate,” says College of Dentistry anthropologist Elena Cunningham. “Their brain [is small] relative to their body.” At least what they lack in intellect, they make up for in sense of smell. Cunningham recently put it to the test—determining that lemurs could use odor plumes to locate food up to 56 feet away in the densely foliated forest at the Lemur Conservation Foundation in Florida. “This is the first time research has demonstrated that primates can track a distant smell carried by the wind,” she says of the ring-tailed foragers.

EYES OUT

Cunningham hid containers of cantaloupe, their favorite food, in the underbrush along the trail, plus some decoy containers, where the lemurs couldn’t see them. But lemurs have wet noses, like dogs and cats, so they rely more on their sense of smell than sight.

BLOWN AWAY

In order for them to find the cantaloupe, the wind needed to be in their favor. On days when the wind was blowing away from the trail, the lemurs couldn’t locate the food. But when the wind was blowing toward the trail, they did find it.

SNIFF TEST

At first, the lemurs trusted their memory, not the odor, going where they’d found fruit before. “Memory sometimes takes precedence over the immediate sensory information. If I smell food, I just go to the kitchen rather than follow the odor plume,” says Cunningham. But cantaloupe is fragrant, and the lemurs then used their noses to sniff out the fruit.



POUR ONE OUT

Before this study, when Cunningham poured cantaloupe juice in trays on the ground under locations where empty containers had been, “one of the lemurs was down the trail, looking at the tree for the fruit,” she recalls. “She was like, ‘It should be there!’ ”

LADIES FIRST

Since ring-tailed lemurs are female dominant, the adult male lemur would let all the females eat before him. “He might lick out the empty containers when they were done,” she says. But the researchers fed him separately to make sure he had enough to eat.

LOOK-ALIKES

To ensure that the lemurs were drawn to the fruit’s fragrance and not its appearance, Cunningham set up containers of decoy cantaloupe. And to pull that off, she did a little craft project: “We used cut-up sponges and tempera paint,” she says. “In the container, it really looked identical.” But the lemurs’ noses knew better, and they didn’t go for the fakes. —R. E.

hml/jar007/istock

TAX EVASION

Paper or plastic? Fielding that question is now a thing of the past for New Yorkers and residents of other states where laws banning single-use plastic bags have been passed. But what about everywhere else? In her studies of effective policies around disposable bag use in Chicago and elsewhere, NYU Wagner economics professor Tatiana Homonoff discovered that taxing shoppers five to seven cents per bag is far more likely to alter their behavior than crediting them the same amount for refusing one—due to a behavioral phenomenon called loss aversion. Below are some of her findings, plus some startling statistics about our consumption habits.

380 BILLION

Approximate number of plastic bags and wraps used every year in the US, according to the Environmental Protection Agency. And all that plastic requires 12 million barrels of oil to create.

18,000,000

Estimated drop in the number of disposable plastic bags used annually by shoppers in Montgomery County, Maryland, after the implementation of a nickel grocery bag tax, according to Homonoff’s findings.

82

Percentage of Chicago consumers who used at least one disposable bag prior to implementation of a seven-cent tax. That number dropped to 49 percent in just the first month of imposing the tax, Homonoff found in her study.

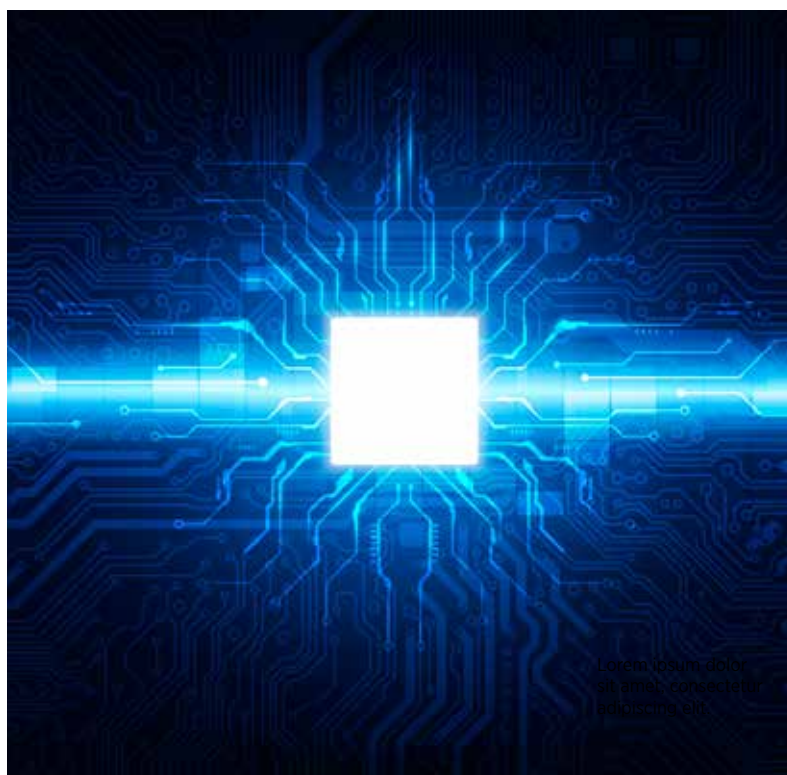
1,000

Estimated number of years it takes for a single plastic bag to decompose in landfill. Most plastic bags end up in landfills—because even though they’re often recyclable, only about 10 percent of them actually *are* recycled in the US, according to the EPA.

60

Number of plastic bags the typical US family collects in four trips to the grocery store. And just 12 minutes is the average amount of time a plastic bag is used worldwide—with only one out of every 200 being recycled on average.

Niserin/istock



Breach Patrol

It happens all too often that news arrives of a fresh data breach at a company that processes precious details about you—your genetic profile, your credit card information, your Social Security number—subsequently followed by a notification informing you that your personal data has been compromised. But the incidence of such digital incursions could be dramatically reduced through the work of researchers at the Center for Cybersecurity at NYU Tandon, in collaboration with data security company Duality, to design a game-changing microchip (code-named Trebuchet).

Michail (Mihalis) Maniatakos, associate professor of computer engineering, and Brandon Reagen, assistant professor of electrical and computer engineering and computer science and engineering, designed the microchip to accelerate and facilitate practical applications of a paradigm-shifting form of encryption. Called fully homomorphic encryption (FHE), it's an advanced cryptographic technique widely considered the holy grail of encryption. FHE will enable users to work with data that remains encrypted while in use, a more secure alternative to the prevalent practice of encrypting data only during transmission and/or storage. There's a sticking point, though: "Despite

FHE's potential to solve many privacy issues, it's far too slow to be used," explains Reagen. "Therefore, large-scale, custom hardware like Trebuchet is really the only way this data-protecting tech sees the light of day." It's been Reagen's goal to develop a chip with enough parallel functionality to allow multiple computations to happen simultaneously at maximum throughput. In other words, information multitasking on steroids that permits data to remain encrypted while being transmitted.

The solution is a strategic combination of streamlined hardware architecture and dedicated logic units that can natively process FHE's underlying mathematical operations. The logic units employ a feature called large arithmetic word sizes (LAWS) to supply the horsepower to crunch the massive numbers involved. The other piece of the puzzle was figuring out how to keep these modular multipliers optimally busy by keeping them fed with data and thus avoiding wasted performance capacity.

According to Reagen, "the overriding theme of the design is to remove all the fat from standard, general-purpose computers, in [figuring out] how to efficiently move the massive amounts of data around that are necessary for each computation." This was achieved by defining a hierarchical architecture and designing customizations like parallel hardware that allow multiple processes to happen at once and at maximum capacity.

The team anticipates that squeezing all the juice possible out of these LAWS units will turbocharge the encryption process. They're now working on perfecting the architecture and multipliers and, eventually, plan to collaborate with the Center for Cyber Security at NYU Abu Dhabi to fabricate a prototype.

The end goal is private machine learning training and inference, enabling scientists to train and use AI systems on encrypted data. "FHE has the potential to revolutionize privacy—no more 'Sorry, we got breached, all your data was taken' excuses," says Maniatakos. "Data will always be processed while encrypted, so there will be nothing to steal." —*Abhimanyu Das*

Panuwat Sikkam/iStock



The 411 on Recording 911

As protesters took to the streets after George Floyd's murder in 2020, First Amendment Watch—an online resource covering freedom of speech and the press at NYU's Arthur L. Carter Journalism Institute—put out a free document for ordinary people outlining why, when, and where they are allowed to film encounters with law enforcement. "A Citizen's Guide to Recording the Police" is an educational tool developed by Stephen Solomon, founding editor of First Amendment Watch and the journalism institute's director.

In Solomon's view, the ease of recording and uploading a video with a smartphone can turn anyone into a potential reporter and "journalists and bystanders have a very strong First

Amendment right to record police officers doing their job in public. It is subject to what we call reasonable time, place, and manner restrictions." For instance, going onto private property is off-limits. Also, an officer can ask someone to move back so as not to interfere and can clear the streets in the interest of public safety during an active shooter situation. "But it would be rare for a police officer to be able to say, 'No, you can't record at all,'" says Solomon. Nor can they seize and search the contents of a phone without a warrant.

The Supreme Court has not yet weighed in on the matter, and the guide includes a map indicating the areas of the country where legal protections are fully secure thanks to rulings by six of the

federal appeals courts. Nearly half of the states (61 percent of the population) are covered, and Solomon assumes everyone outside those jurisdictions are as well, given that the six courts "ruled unanimously and very strongly" on that First Amendment right. He expects the remaining courts to follow the precedent as cases arise.

As it turns out, it's not only average citizens looking to be educated. First responders don't always know the law, and "it's led to arrests and a lot of lawsuits," Solomon says. The Los Angeles Fire Department, Colorado state judges, and some police departments are among those who have downloaded the guide or invited Solomon to speak on the subject. "That part of it," he says, "was unexpected." —*D.I.*

garett_mosher/iStock

SOUND BODY, SOUND MIND

For 32 years, 1,051 people with type 1 diabetes have been prodded, poked, and appraised in service to a study—the longest ongoing one of its kind—led by NYU Long Island School of Medicine chief research officer Alan Jacobson. The psychiatrist's aim: to determine how the disorder, marked by the pancreas's failure to produce insulin, affects cognitive ability.

Subjects in their 50s and 60s, particularly those whose blood sugar levels and blood pressure have often veered into dangerous territory, had a tougher time recalling words and recent events and were slower at performing "higher" brain functions. The analysis also showed that most of the 59-year-olds demonstrated the brain function of someone nine years older.

Although dementia has long been linked to the disease, Jacobson's study is unique in that it measures progressive losses in brain function in participants who are in their late 50s and 60s—a time of natural decline, even for the healthy.

Says Jacobson: "These results offer compelling evidence of the importance of maintaining tight control over blood sugar levels, as well as blood pressure, to benefit not just heart and kidney health, but for maintaining healthy brain function." —*D.I.*

Can't Stop That Feeling

There's no point in trying to completely eliminate anxiety from your life, says neuroscientist Wendy Suzuki. What you do with it, however, is another matter

We all have some level of what NYU professor of neural science Wendy Suzuki calls everyday anxiety—even more so as we're now in year three of a global pandemic. In her book *Good Anxiety: Harnessing the Power of the Most Misunderstood Emotion* (Atria Books), Suzuki seeks to reduce the shame attached to feeling anxious, offers tips for managing anxiety (everything from watching funny TikTok videos to taking a walk), and shares ways that anxiety can be used to develop “superpowers.”

So, what is anxiety?

Anxiety is that feeling of fear and worry typically associated with unpredictable situations. Everybody experiences some sort of anxiety, because we're designed to think and worry about the future. It's part of our emotional wheelhouse.

How has the pandemic changed things, in terms of everyday anxiety?

One report before the pandemic suggested that 90 percent of the population experienced anxiety on a regular basis. I think it's pretty safe to estimate that in this time of variant after variant, within the context of a global pandemic, anxiety levels have gone up. Lots of uncertainty. Lots of fear. Lots of worry.

Why did you write this book?

There's a lot of shame associated with anxiety because it's like, “There's something wrong with my brain.” What I'm trying to do in the book is reduce the stigma and give people tools to calm the feeling of anxiety, because that physiological stress response that gets activated with anxiety is really such a

drain on our everyday energy. It is making us less productive, and making us less happy.

Where should people start when it comes to addressing anxiety?

There are two starter tools. One is deep breathing. The science behind that is twofold. One is that you're activating the parasympathetic nervous system, the counterpart to the “fight or flight” part of the nervous system. Deep breathing is also one of the oldest forms of meditation. I recommend box breathing, which is inhaling for four counts, holding at the top for four counts, exhaling for four counts, and holding at the bottom for four counts. My second tool is something I've studied in my lab, which is the effects of moving your body on the brain's physiology and function. Every single time you move your body, you're releasing what I like to call a neurochemical bubble bath, full of neurotransmitters like dopamine, serotonin, and endorphins. All of these decrease anxiety levels and increase positive mood states. So that is the science behind why going for a walk can make you feel better.

You say you learned to use anxiety, and that others can use theirs, to develop “superpowers.” How so?

I've always had social anxiety. As a student, I was terrified of asking questions in class, terrified that the teacher was going to say, “Oh, what a stupid question.” And that's turned into one of my biggest superpowers—empathy as a teacher. There are many students that feel exactly like me. I'm not going to call them out and just say go ahead and ask the question. I'm going to be available before or after class because it's easier to ask me directly rather than to have to share your question with everybody. I was doing that unconsciously, but then when I started writing this book, I realized, “Oh, that is one of my superpowers.” You have this power to reach out, recognize that anxiety in somebody else, and help them. And that is a beautiful gift to have.

Should we be trying to get rid of anxiety altogether?

Am I saying read this book and you'll get rid of all anxiety? No. Evolutionarily, anxiety was a warning system—pay attention to that lion that may be around the corner waiting to eat you. There are definitely things we should be anxious about. Part of deactivating the warning system is doing something about it. That's another superpower in the book—the tool of productivity that comes from your anxiety. Many people have anxiety around things they have to do. Should I be thinking about this article that I have to write for an important science journal? Absolutely. But should this be keeping me up until 3:00 a.m.? I turn all that worry into a to-do list. Then



Suzuki will become dean of the College of Arts and Science in September.

when I do each thing, I'm going to put a checkmark next to it, and checking off helps me with that evolutionary anxiety.

Are some people better equipped to deal with anxiety than others?

The people that tend to have a little bit of a head start are people that have already practiced positive psychology. Having a

positive outlook is very powerful. If you don't have as much experience with that, it is absolutely learnable. That becomes a superpower, because those with lots of anxiety have lots of practice thinking up other ways to approach that worry and reframing in a way that can be very advantageous.

What do you hope readers will take away from your book?

My wish is that they learn how to turn the volume down on their anxiety and lean into these uncomfortable emotions to learn how to develop superpowers. My hope is that in the end, the book will help them live a more fulfilling, more creative, and overall less stressful life.

Social Animals

When Hurricane Maria ripped apart their tiny island home, a colony of rhesus macaques became a study in trauma and social behavior that could have a bearing on humans

“What doesn’t kill us makes us stronger” is a cliché that most of us rarely question. But is it actually true? Does overcoming adversity have the power to change us, and if so, how? Those are among the big questions scientists are now exploring on a tiny island off the coast of Puerto Rico, with help from a bunch of monkeys.

A little background: Cayo Santiago, as the small landmass is known, has a population of exactly zero humans and about 1,500 rhesus macaques. The fuzzy, long-tailed, two-foot-tall creatures—who top out at around 30 pounds—are actually native to Southeast Asia. But way back in 1938, primatologist Clarence Ray Carpenter chartered a boat in India, filled it with 500 of the petite primates, and plonked them down on this tropical isle in the name of science. About two decades later, biologist Stuart Altmann tattooed the monkeys for easy identification and started keeping a detailed, longitudinal census, thereby establishing Cayo Santiago as one of the world’s foremost field laboratories. For more than half a century, scientists from top research institutions—including NYU—have sailed the half-mile from the mainland to study the health and behavior of the animals in a naturalistic, free-ranging environment. And then, in September 2017, the island earned another, much less desirable, distinction: it was the first

stop on Hurricane Maria’s devastating tear across Puerto Rico.

“The hurricane destroyed all of the research structures, flooded large portions of the island, and pretty much wiped out all of the vegetation,” says James Higham, an associate professor of biological anthropology who has worked on Cayo Santiago for more than a decade.

The goal in studying the monkeys’ social behavior is to gain insight into our own—as scientists are discovering how important social connectivity is to our physical well-being.

Happily, when staff were able to get to the island, wading in from their boats because the docks had been swept away, they were pleasantly surprised to find that the monkeys had made it through. “There was some higher mortality in the couple of months afterwards relative to previous years, but generally the population of monkeys survived,” says Higham. “We don’t know what they did, whether they huddled or found whatever shelter they could. They’re very low to the ground relative to us, so that also makes them less exposed to the elements in some ways.”

Still, just because the animals had lived didn’t mean they hadn’t been affected. The only environment they’d ever known had been turned upside down, and, says Higham, “they were outside throughout the whole of the storm, which was presumably extraordinarily traumatic.”

In the months that followed, crews worked to repair the island’s infrastructure, and, before long, scientists were able to get back to their research, this time with an additional—and timely—area of focus. Because they had so much data on the monkeys both before and after the storm—everything from preserved brains and bones to fecal and urine samples and copious behavioral logs—they could make some fascinating comparisons. How was the health and behavior of the macaques affected by living through the type of major natural disaster that, thanks to climate change, seems to be occurring with alarming frequency these days?

Some possible answers are starting to roll in. In a study published in *Current Biology*, Higham and his coauthors looked at the monkeys’ social relationships before and after the hurricane. Their findings: after weathering the storm, the monkeys were more tolerant of one another and formed new bonds. “In particular, it was individuals that were socially isolated before the hurricane who made efforts to increase their rate of social behavior toward others,” says Higham. “And they didn’t just target their existing social partners; they made new social connections.”

The research, of course, is about more than just primate popularity. Because they share about 93 percent of our DNA, the rhesus macaque is the number one



Hurricane Maria may have accelerated the aging process in rhesus macaques living on the island of Cayo Santiago.

Courtesy of James Higham

nonhuman primate model for human health in the world. “More than 70 percent of all primate research for human health is done on macaques,” says Higham, who points out that the animals were used heavily in the development of the COVID vaccines. One major goal in looking at the monkeys’ social behavior, then, is to gain insight into our own—and, more and more, scientists are discovering just how important our social connectivity is to our physical well-being. “The number and quality of your relationships is one of the top predictors of your health,” says

Higham. “Having a poor social environment is as high a health risk factor as smoking, and degree of social support is one of the top predictors of five-year cancer survival rates.” The interesting takeaway from this study, he adds, “is to see how flexible social behaviors in response to a natural disaster might help individuals buffer their stress and anxiety and might help with their resilience.”

As one measure of that resilience, Higham and his colleagues recently compared the molecular age—basically a measure of the rate at which the body is

aging—of monkeys who lived through the storm with that of those who’d died before it hit. What they found is that hurricane survivors are potentially aging at a faster rate. The next logical step: measuring how social relationships affect the pace of that acceleration. “How does sociality get under our skin and become our biology?” says Higham. To put it in entirely unscientific terms, some clichés are apparently truer than others. What doesn’t kill us may actually make us older, not stronger, but we may get by with a little help from our friends.

A Dark Crystal, Rediscovered

Why was an insecticide more effective than DDT ignored for seven decades? A pair of chemists finds the answer in its surprising origins

Crystals are everywhere: in rocks, snowflakes, salt, sugar, commercial products like aspirin, even medical conditions such as gout and kidney stones. In fact, says Michael Ward, Silver Professor of Chemistry, crystallization is the third-largest industrial process in the country. And exploring that process is what compelled Ward and his fellow NYU chemistry professor Bart Kahr to begin researching the insecticide DDT. Little did they know they were about to go down a crystalline rabbit hole.

The research team initially undertook a study of the infamous mosquito killer “not because it was an insecticide but because it was a crystal,” Kahr explains. Specifically, they were interested in crystals that twist as they grow, and DDT happened to be one of them. DDT was by then a “pariah substance” in most of the world, Kahr says, its environmental damage having been documented decades earlier by Rachel Carson in her book *Silent Spring*. But since it hadn’t been studied in recent times, there was a lot to learn. Ward and Kahr discovered that the crystal structure of DDT was polymorphic, meaning that the crystals can take different forms. Ward compares the phenomenon to hats hanging on different racks—one with a square lattice of hooks and the other with a triangular lattice. “You’d have the same hats but

they would be arranged differently.” If the hats can be rearranged, different versions of a product are possible.

DDT is absorbed through the feet of insects when they walk on its crystals. Ward and Kahr wondered if different crystal forms could kill disease-carrying and crop-destroying pests before they

Would things be different if we had paid more attention to science, not politics, before over 2 million tons of DDT were sprayed in the United States?

reproduce and their offspring develop resistance. So they replaced two of DDT’s chlorine atoms with two fluorine atoms. It’s an obvious tweak, says Kahr, because chlorine and fluorine are in the same column in the periodic table. Tests of the resulting formulation, DFDT, showed it killed insects two to four times faster than DDT.

As the chemists continued to explore DDT and DFDT, they made another extraordinary discovery: DFDT had already been created by German scientists during World War II. The Germans’ goal was to build a better

insecticide and to avoid having to pay a patent fee to the Swiss company that invented DDT. But regardless of motive, DFDT was the superior compound—a fact the world ignored for over 70 years.

“There was a distaste for German science,” says Ward, “and probably a feeling that German science was inferior.” Digging into the bowels of the Library of Congress, Kahr found “dismissive” post-war interviews of German scientists by British and US government officials who seemed intent on not facing the possibility that their former enemies had anything of value to contribute. And because DDT was already established by the time DFDT came to light, US companies, suggests Ward, “had a vested interest in keeping DDT alive and not following up on DFDT.” He also notes that DDT might have had an economic advantage because chlorine is cheaper than fluorine.

Would things have been different if Americans had paid more attention to science, rather than politics, before more than 2 million tons of DDT were sprayed across the United States? “I can imagine that outcomes might have been very different, but for good or ill, [it] will remain a mystery,” says Kahr. “There were no controlled trials of DDT versus DFDT.” Adds Ward: “While the greater effectiveness of DFDT may result in less being used compared with DDT, we know nothing about the ecological consequences of using even a smaller amount.”

DDT and DFDT continue to stir controversy. In 2017, the two professors published their first findings in the international journal *Angewandte Chemie*, along with an essay they wrote



The chemists have now created a more effective crystal form of the insecticide deltamethrin.

Courtesy of Jingxiang Yang

defending Rachel Carson against vicious attacks by deniers of climate change advocating for environmental deregulation. Then in 2019, the *New York Times* reported on the team’s discovery of DFDT and its German background. The story referred to the insecticide’s development as “Nazi” science and ran a misleading photo in its online edition of a concentration camp prisoner being deloused with DDT, which was used to protect against typhus, by a British liberator. Some readers were understandably unsettled. Kahr, who is Jewish, says he understands why emotions ran

high but adds that “this was never a ‘Nazi’ insecticide. It was something that was used by the German armed forces” to protect troops against malaria on their far-flung campaigns.

Ward and Kahr, meanwhile, are carrying on their study of insecticides. By heating and cooling a commercially available form of deltamethrin, they have created a new crystallized form that is up to 12 times more effective against mosquitos. Their findings were published in the journal *PNAS*. “I don’t want insecticides in the world,” says Kahr. “On the other hand, it’s unlikely we would be

able to feed 8 billion people in the world right now without them. And we don’t have another way of combating mosquito-borne infectious diseases effectively,” including 400,000 malaria deaths every year, most of whom are African children. Figuring out how to use smaller amounts of insecticide more efficiently is key to saving more lives, he adds, “and maybe crystallography can play a role here. We think it’s possible.”

MORE ON THE
WEB

See more of the chemists’ kaleidoscopic crystal images at nyu.edu/scope/dfdt

Melting ice shelves spell big trouble
for sea levels. Climate Scientist
David Holland is working at the
ends of the earth to figure
out just how much

By Audrea Lim

On Thin Ice



David and Denise Holland were closing down their camp near Greenland’s Helheim Glacier one night in 2018 when an awesome noise like an approaching train broke the stillness. Standing high on a cliff, with the midsummer sun still hovering high above the horizon, the couple looked down onto the vast expanse where ocean meets ice and saw a colossal chunk of the glacier breaking off. The mass was one-third the size of Manhattan—and, as it fell, was cracking into fragments, plunging into the frigid waters below. “First of all, you scream and shout, because it’s just so amazing to watch,” recalls David, director of NYU’s Environmental Fluid Dynamics Laboratory and NYU Abu Dhabi’s Center for Global Sea Level Change. The surround-sound thunder like gunshots and explosions “kept going and going and going,” he says. “It was just 20 minutes of pure adrenaline.” But in that same moment, another set of thoughts was also racing through his head: “Oh, my gosh, this is so complicated!” To predict future sea level rise, “we need to understand what we saw,” he reflects. “And we are so far from understanding.”

What the Hollands witnessed is known as a calving event, when ice shelves fracture and pieces fall into the ocean to become free-floating icebergs. David has been studying them since the ’90s. While they are a normal occurrence, recent accelerated calving has caused entire ice shelves to collapse in Greenland and Antarctica. When snow accumulates on land, lowering the global sea level, it’s called land ice and can be several miles thick. When land ice flows toward the ocean, thanks to gravity, it forms a marine ice sheet. This displaces ocean waters and raises the global sea level. The marine ice sheet thins as it spreads and goes afloat on the ocean, where it accumulates onto mile-thick ice shelves floating in the water but still anchored to the land ice, like a crust. Because ice shelves are in contact with water, they are more prone to melting, which can lead to a calving event. Ultimately, the ice shelves hold back the land ice and slow its progression into the ocean. When a piece of ice shelf calves off, it makes way for more land ice to flow into the ocean. That is why understanding calving is critical for grasping why the fate of the planet hangs on the issue of ice.

David grew up in St. John’s, Newfoundland and Labrador, where snowstorms were an opportunity to miss school, and he was fascinated by the Arctic explorers who braved the northern ice a century ago. That wonder stayed with him, and he studied sea ice for his PhD. Sea ice has received more media attention than the marine ice sheets he now studies. Sea ice is like an ice cube that melts in a glass of water, having no impact on the level of the water. Sea ice does affect the planet’s color, its whiteness reflecting sunlight into space, which helps keep the planet cool.

The disappearance of sea ice is thought to be caused by global warming, and the replacement of white sea ice by blue ocean waters will push temperatures even higher. But a marine ice sheet’s impact punches above its weight, as it not only affects the planet’s color but also controls the global sea level.

David turned his attention to the ice shelves after joining NYU’s Courant Institute of Mathematical Sciences in 1998, approaching the subject of ice melt from a theoretical angle, and creating models of how calving might occur from warming ocean currents and shifting winds. It was “virtual reality,” as he refers to the models, intended to forecast different scenarios for the future based on changing conditions, like a TV weather forecast showing high- and low-pressure systems feeding a hurricane near Haiti, then pushing it toward the US coast. “You could play the math model just like Pixar movie animation, and you can see these different scenarios,” he explains. For a decade, he sat at his desk creating such climate models. He predicted how ocean currents would melt the ice and raise sea levels, “but with no way to say that was right, that it mattered.”

All of that changed with an accidental discovery. In the late ’90s, satellite images began showing parts of Greenland falling apart at an alarming rate. The melting Jakobshavn Glacier

The Hollands looked down onto the vast expanse where ocean meets ice and saw a colossal chunk—a third of the size of Manhattan—breaking off and plunging into the waters below.

drains Greenland’s ice sheet—its land ice—to the Ilulissat Icefjord, a shelf hanging into the sea, and David’s models postulated that warm water had caused the calving. But scientists lacked evidence to support this, until the Hollands learned that Greenland’s fishermen had been attaching Post-it-size sensors onto their nets for years, thanks to research efforts by local fisheries. The fishermen shared the data with David. “We couldn’t believe it,” he recalls. “It was this incredible historical record that nobody had seen,” showing that the same period when the glacier was disintegrating corresponded exactly to when, according to the fishnet sensors, warm water suddenly arrived in Greenland. It turned out that part of the Gulf Stream, a warm ocean current flowing past Miami toward Europe, had looped around and crashed into Greenland. The reasons for this are still unclear, but the discovery showed that David’s model

Previous spread: Paul Souders/Getty Images



The Hollands’ polar expeditions require ships, helicopters, and military transport aircraft.



Courtesy of Denise Holland

had legs, and it also fine-tuned his scientific understanding of how ice melt is connected to sea level rise and climate change. “We had done 15 years of theoretical work first, and then we saw all these events actually happening in nature, which was kind of weird,” he reflects. “We were kind of primed to understand it.”

David pivoted to field research and to the questions that would continue firing off in his mind years later as he watched a huge piece of the Helheim Glacier collapse—an event so complicated that he wondered, “How are we ever going to produce a forecast?” Unlike the weather, which researchers have been measuring and studying for over a century, scientists do not



understand the mechanisms that cause ice shelves to fracture and melt. “The weather and the flow of air is relatively simple science in comparison to the science of trying to understand something that breaks,” he explains. But above all, they needed more data: temperature sensors in the water, and sensitive radar detectors to measure movement and fracture in the ice. “Hurricanes are complicated, and we have mastered that to some degree, so maybe it’s just a few decades of research and we’ll get there,” he says.

For the past 15 years, Denise has been organizing and running their research expeditions to Greenland and Antarctica as the field

manager, tackling the logistical problems that have all but prevented researchers from gathering ample data. The first problem: remoteness. The ice sheets sit at the top and bottom of the planet, unlike the weather stations that scientists have set up at every major airport and throughout the continents of the world. She ships their sophisticated robots and testing equipment from New York City to the polar regions on US Air Force planes, but from



there they can't just rent a truck—there aren't even roads along most of the coast. She charts helicopters and icebreakers to navigate the local waters, and she plans meticulously. "If I forget one bolt or one screw," she says, "the whole thing falls apart"—or they may have to pay someone thousands of dollars to ship it. The second problem: the harshness of the climate. A few years ago, one of their icebreakers sank. The Icelandic captain was on



In Greenland's icy waters, ringed seals with temporary sensors can reach unnavigable sites.

Courtesy of Denise Holland

his way to meet them in Greenland, his family accompanying him on board, when the sea ice crushed his boat "out in the middle of nowhere," says David. A giant military rescue helicopter arrived, but its rotors created heavy waves and couldn't complete the mission. Finally, a smaller helicopter lifted the captain and passengers off the boat before it sank. Helicopters have their own risks too. Many of the sites they visit can't be accessed by boat, but helicopter engines sometimes fail mid-flight, for instance. Thankfully, the engines usually come in twos.

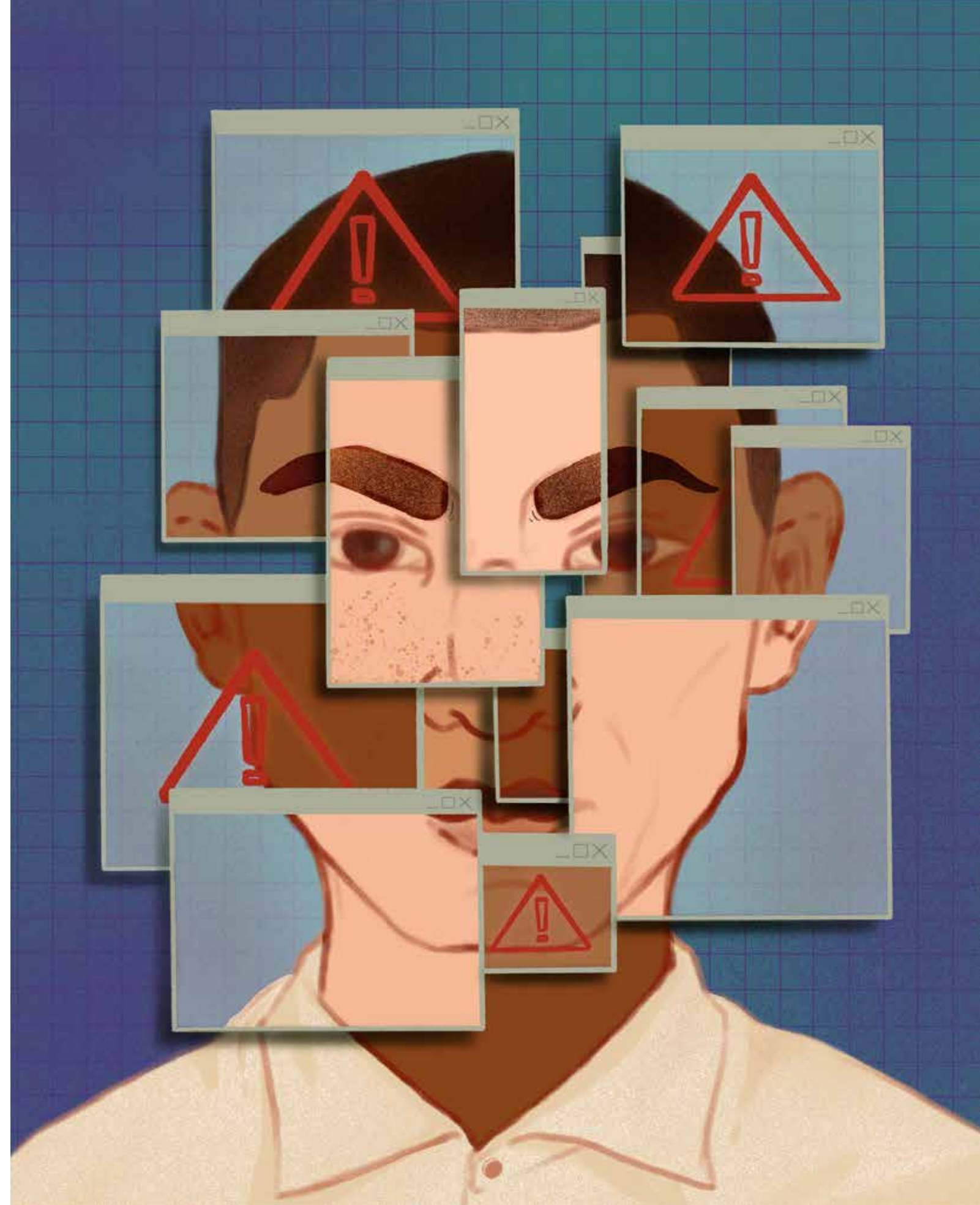
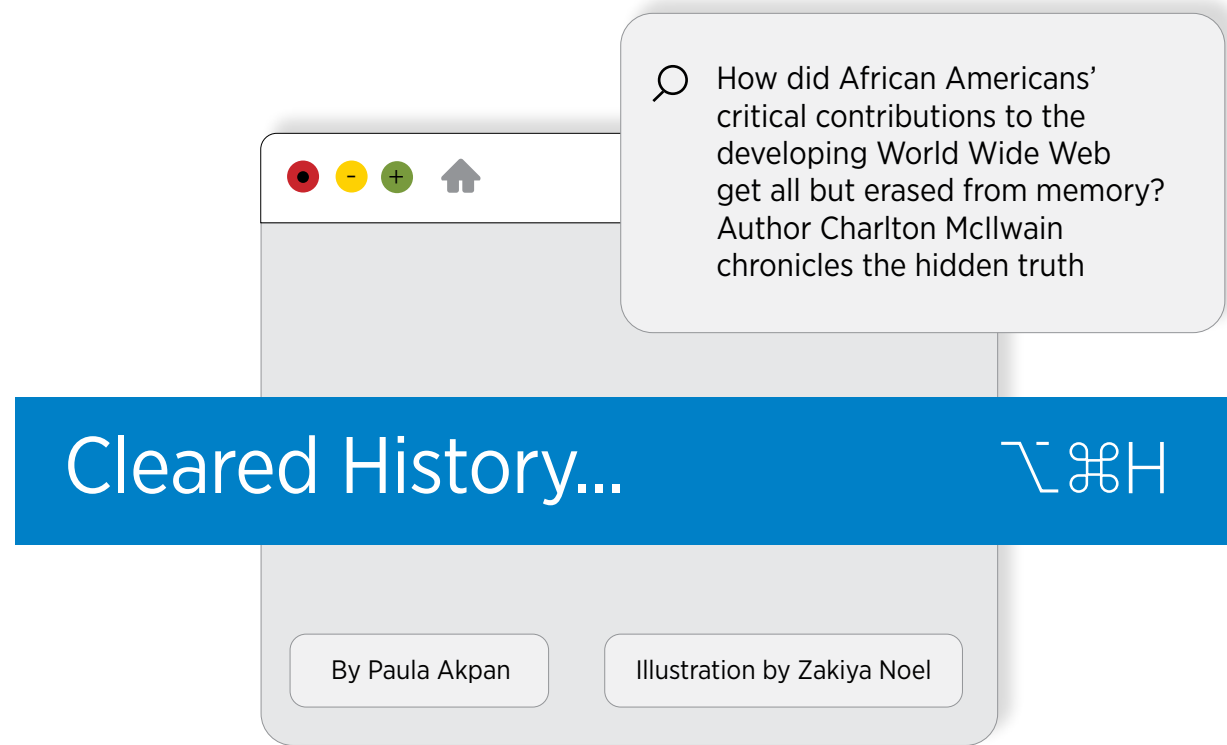
"You only have one month," David Holland says of working in the remote, harsh Antarctic climate. "If you don't leave by then, you're never leaving."

Denise happened upon an innovative workaround to this problem several years ago. At a logistics meeting in Greenland, a biologist mentioned the wealth of data they were gathering on the continent's wildlife, including studies of seal habitat and behavior. "There is a great opportunity here to extend that data collection to include things that we want to know about the ocean in Greenland," she told him. The Hollands were curious about the temperature, salinity, and depth of the waters where the seals traveled, in the waters just off the ice shelf. The biologist suggested that they attach tags to the seals' necks—muffin-size sensors that fall off after a year, whenever the seals molt their fur. "So we just started a collaboration, and it's been really useful, really interesting," she says. They now tag six seals a year—three on the east coast, three on the west. But the logistical and scientific challenges remain abundant. Understanding why the ice shelves break is a mystery, akin to the earthquakes that scientists have yet to predict, and the Hollands are installing radar sensors close to the glaciers to measure their movements. But Greenland's forceful winds "rip everything apart," says David. "That's been part of the slowness of understanding things." However, the "biggest threat to sea level in the world" resides on the opposite pole: the melting of the ice sheet in Antarctica, which is "bigger, badder, more difficult" to get to, and therefore much less understood. In the brief, sunny window of January, the Hollands sailed with a team from New Zealand to Antarctica,

then helicoptered to where they set up camp by the Thwaites Glacier. It is disintegrating from the warm Antarctic Circumpolar Current. Drilling through the half-mile-thick ice shelf with hot water, they dropped a temperature sensor into the ocean below, which will record and transmit data for the next few years. "We're drilling one hole, not a thousand holes, because you only have one month before you have to leave," says David. A helicopter can only bring so many barrels of fuel, limiting the number of sites they can visit. "If you don't leave by then, you're never leaving, because nobody can get there," he says. "The weather goes too bad." When they drilled a hole in the glacier in 2020, it was the first time scientists had recorded unusually warm water flowing underneath. Their discovery was made at the glacier's grounding zone, which is key to its overall rate of retreat. Because the Thwaites Glacier is roughly the size of Florida, its collapse could have significant global impact. But so many unknowns puncture the overall scientific understanding about sea level rise that there's no way to forecast exactly how, when, and by how much it will rise, says David. "The big picture is that the planet is warming," he says, and "that humans have had an influence on that warming." But we have a weak understanding of how humans have altered global wind patterns, how the winds are changing ocean currents, and how these currents are fracturing the polar ice shelves. David's research has made him more realistic about climate change: it is happening, but scientists are far from understanding how it will play out. Despite the challenges of carrying out this research, most outdoor adventurers can only dream of visiting these polar locales, which "are beyond beautiful," says David. "Just the sense of being on an ice sheet, on a glacier, and there's no one around for a thousand miles ..." Except for the wildlife. "Giant [polar bear] tracks always make us nervous. They're always walking by, and you don't want to meet them." In Antarctica, the penguins are "supremely amazing," always standing together in silence. "They stare at you like they're saying, 'What are you doing?'" he says with a chuckle. "And they always win the staring contest." Recently, Denise was cooking bacon at a remote camp in Greenland when the pair spotted an arctic fox watching them from behind a rock, "like 'You can't see me!'" he recalls. Denise put out some bacon. (Though "you shouldn't do that [more than a few times] because they become dependent," David notes.) The fox accepted the gift and was deeply impressed. The next day, she brought her whole family—two little cubs. Research, for the Hollands, is wilderness camping in a place where "everything around you is ridiculously beautiful," David says. "So doing it as a family unit is perfect."

MORE ON THE
WEB

Watch the massive iceberg break that the Hollands captured in Greenland at nyu.edu/scope/hollands



Once upon a time, the internet held what seemed like unlimited promise for Black people, full of self-governed sites offering music, literature, news, discussion, and more. Those long-gone days when African Americans were instrumental in determining what was available online is the subject of *Black Software: The Internet and Racial Justice, from the AfroNet to Black Lives Matter*. Written by Charlton McIlwain, a Steinhardt professor of media, culture, and communication and NYU’s vice provost for faculty engagement and development, the book is a powerful and troubling history of the internet’s infancy and evolution—one that reaches back decades but links directly to Big Tech’s perpetuation of inequality today.

McIlwain initially set out to better understand how Black Lives Matter so adeptly deployed digital tools—including #BlackLivesMatter—to harness a racial justice movement in the wake of the killings of Trayvon Martin, Michael Brown, Eric Garner, and others. “I knew at least part of my pathway was going to end up in the early mid-’90s at the dawn of the World Wide Web,” says McIlwain, who also founded the Center for Critical Race and Digital Studies at NYU’s Institute of Human Development and Social Change. But in interviews with Black activists, organizers, and key computing tech figures, he learned that their contributions to the internet dated even earlier than he’d imagined. “I would ask them, ‘When did you first get online?’” William Murrell, one of IBM’s first Black engineers and the owner of Boston’s largest computer store, MetroServe Computer Corporation, thought a long while before replying: “I think about 1978.” It was a revelation for McIlwain, who guessed he needed to travel as far back as the 1960s, where he ultimately found a trove of “voices and stories that certainly I had never heard before. My sense was that no one else had.” Suddenly, the question “What is, and has been, Black people’s relationship to the internet and computing technology?” was propelled to the top.

Searching for answers meant working backward from the present. “It’s been an interesting story, especially since it starts with some of these current observations about algorithmic bias and anti-Blackness and technology,” says McIlwain.

He discovered that the early emergence of computing technology was intertwined with the civil rights movement of the ’60s, with big tech companies such as IBM collaborating with agencies all over the country to spy on and profile Black Americans. That was a bombshell for McIlwain, who had believed the connection between the NYPD and IBM had existed for only a few years. He thought: “Oh, you completely missed the story because this was not a five-year relationship, it was more than 50 years—[and not only] in terms of the general connection between law enforcement and technology but in the specific relationship between the NYPD and IBM,

which has been a continuous history since the early 1960s.”

And of course, prospective Black engineers were historically denied entry into predominantly White educational institutions, which meant they were excluded from employment in tech companies, which in turn affected their ability to take part in developing computer software. Each lost opportunity knocked against the next, tumbling like dominoes.

Remember When the Internet Was Black?

“Early in the writing of the book, I had come across an encyclopedia of Black inventions—or something like that,” says McIlwain. “It was a very, very, very thick volume written by Black folks.” Naturally, he headed to the index and looked up the word “internet.” There he found a short entry along the lines of “No person of African American descent has had anything significant to contribute to the invention of the internet.”

He was astonished by this conclusion, given that Black scholars had researched and authored the work. But he also recognized that the definition of technological intervention tends to focus on individual people and specific material artifacts—hardware, software, and so on. “Because of that,” says McIlwain, “we look back and say, ‘Oh, because there’s no one that we see that was working at MIT that had a patent or this, that, and the other,’ we don’t make a connection between Black folks and these technological innovations.”

McIlwain rejects this narrow framing. In his view, “Black culture, Black style, Black ways of engaging” powered the internet of the early 1990s, “when it really was all about a big machine and cable modems and people didn’t know what it was

Content about Black culture persists today, but “what has changed is about ownership, and that’s what you no longer see, in the way that seemed promising in the early days.”



McIlwain is the founder of NYU’s Center for Critical Race and Digital Studies.

going to be good for, much less how we’re going to make money off of it.” He decided, “All right, I’m gonna tell this story around key people I’ve talked to whose stories and retellings about the early internet, from the late ’70s on up through the ’90s, was very palpable.” Both technologically and culturally engaged, these early embracers of the internet demonstrated the potential significance of this new medium in terms of building communities and connections—“the fundamentally social aspect of the web that we know today,” he says.

“The Vanguard,” as McIlwain calls the African American technologists who were instrumental in constructing computer-based networks—essentially social networks—in the late ’80s through the early ’90s, “were on the leading edge both as users and hobbyists,” he says. “They very much had a hand in shaping what the early web was in its first few formative years.”

Leading the Charge

Among tech’s Black pioneers was a lawyer named Kamal Al Monsour who also worked at NASA’s Jet Propulsion Laboratory. He founded AfroLink Software, an electronic bulletin-board system that shared information about Black and African history, culture, and politics. By the mid-’90s, the software catalog included “several volumes of clip art, history programs, educational games, and language training programs in Arabic, French, and Swahili,” writes McIlwain. Another was Derrick Brown. A computer scientist/engineer from South Carolina, Brown mentored Black students in technology and helped create the first Black-focused internet search directory, the Universal Black Pages, in 1994. William Murrell not only

operated Boston’s largest computer store, but he also oversaw CompuServe’s Go Afro social networking forum, which featured bulletin boards and real-time chat rooms. Anita Brown was named “the best-known Black woman on the web” by *WIRED* magazine after the 1996 launch of her internet-based community organization, Black Geeks Online, which connected thousands of tech-savvy Black people to one another, as well as to Black communities in need of increased computer literacy and internet access.

In 1995, journalist Farai Chideya created *Pop and Politics*, one of the earliest blogs, and on Juneteenth of that same year, E. David Ellington and Malcolm CasSelle launched NetNoir. Funded by AOL’s Greenhouse Program, NetNoir distributed Afrocentric literature, music, sports, education, and business news to a segment of AOL users who previously had no reason to connect online. “It’s essentially the first cultural commodity that’s bringing folks to the web, meaning I could see stuff on there that I like, that represents me, that makes me want to buy an extra phone line and an AOL subscription,” says McIlwain. “That happened by the millions—and to think: it was through a company built on Black content!” Unfortunately, he adds, when Ellington and CasSelle sold the company in the late ’90s, “it becomes something completely different.”

Stories like Ellington’s and CasSelle’s illustrate how the advancement possibilities tied to the internet’s formation by early Black entrepreneurs were lost due to a lack of capital. Although content about Black culture persists on many platforms today, says McIlwain, “what has changed is about ownership, and that’s what you no longer see, in the way that seemed promising in the early days. Where do you find a highly visible, highly profitable, Black-owned internet-based media

“It wasn’t long after Black Lives Matter activists began to use Facebook and Twitter that law enforcement used those same tools to surveil, arrest, and jail activists.”

company today? With the growth in commercialization of the web, the early Black entrepreneurs either failed or became successful by selling their businesses and going on to other things. And almost everyone I spoke with lamented how, between the ’90s and now, all of these possibilities for the

internet as a tool for economic advancement really vanished.”

Black Software ultimately became a historical account of why “at every moment where there seems to be an opportunity for Black folks to use technology to get ahead, it seems we end up further behind,” says McIlwain. “As people figured out how to use the new medium, people who had more money simply overtook us. They were not necessarily smarter or more skilled in terms of software development, but they had greater access to capital and we simply could not compete.”

McIlwain points to behemoth search engines, like Google, which, he says, are “both a vast repository of content” and “decision-making vehicles” and that make “assumptions about what the user wants, based on popularity.” One student’s experimental search for “breast cancer” yielded information that by default pertains to White people, while “the hundreds and hundreds of pages on breast cancer specific to the needs of Black women were hidden,” he says. “You can imagine how that can create a wide-scale gap, based on race and other factors, between sites authored by different types of people.”

The New Age of Automated Criminal Justice

Embedded in the history of Black technological advancement is the weaponization of tech against Black life. Fear, misinformation, and the use of tech in law enforcement merge with dangerous consequences.

When the frustrations of LA’s Watts community bubbled over for six days in August 1965, writes McIlwain, a commission appointed by California’s then-governor Pat Brown found its residents had been starved of education and work for too long. But IBM sponsored a CBS special report on the Watts uprising that sensationalized and platformed anti-Black positions. The company also sought out federal contracts for data processing applications that could aid in programs to process fingerprints, deploy patrol, and more. Eventually, millions of dollars were poured into resources that became known as Criminal Justice Information Systems.

IBM systems engineers guided the creation of an algorithm that could be used to determine how many police officers should be dispatched to a call. A “suspicious” Black person in a “low threat area” might result in the arrival of four squad cars. This eventually led to the creation of Kansas City’s ALERT II system in August 1968, which was touted as a harmless tool to help police work more efficiently with its weighted crime formulae.



Technology Today

Though the age of dial-ups may feel like a distant memory, the inequities of those early days continue to have a devastating impact. As of 2020, the Kapor Center reported that Black talent makes up just 5 percent of the tech workforce, 3 percent of tech executives, and 1 percent of tech founders. Considering the continued trends of hiring from “top-tier” universities, bias in recruiting practices, and pay inequality, Black tech employees won’t achieve parity until 2068.

The Black Lives Matter resurgence in the summer of 2020 demonstrated how crucial the internet has become for sharing videos that demand accountability or as a tool to educate about one’s rights, learn from Black critical theorists, or crowdfund bail for arrested activists. McIlwain is encouraged by how the movement has marshaled “digital tools to do something we hadn’t managed to do in the 50 years prior, which is to make race, criminal justice, and the effect of the criminal justice

system on Black people front and center in the public agenda.

“But on the other hand,” he continues, “it wasn’t long after Black Lives Matter activists and others began to use tools like Facebook and Twitter that law enforcement began to use those same tools to surveil, arrest, charge, and jail activists. It’s a cycle: communities and activists find a way to leverage a new tool toward a good outcome, and then law enforcement or corporations come back with a corrective that thwarts those interests.”

As a result, says McIlwain, “I don’t think we’re going to magically start building equitable systems that work to further the interests of marginalized folks. But I do see a future where people are still using technology to challenge, to push, and to counter the interests of those in power.”

Acknowledging the unheralded inventors who populate the pages of McIlwain’s book—and could probably fill a couple of volumes of the encyclopedia he unearthed—is critical. It’s also long overdue. “When I approached these folks,” says McIlwain, “I really got the sense that [they’ve] been waiting for someone to ask them these questions for decades.”



Courtesy of Betsy Coker

Elizabeth “Betsy” Coker’s research is a perfect pas de deux between art and science. Why art? Because, as a longtime professional dancer and now an assistant arts professor in the Department of Dance at Tisch, Coker understands instinctively how the body moves to music. Why science? Because, building on her dance background, Coker has made movement science her life’s work. “As a creative practitioner, I’ve spent my entire life thinking about moving,” she says. “It is the thing that has occupied all of my thought and imagination since I was a kid.”

Something in the Way We MOVE

Dancer-turned-scientist Betsy Coker’s new app aims to detect issues of mobility and balance—even before a diagnosis

By Alison Gwinn

Indeed, Coker was only 3 when she began training as a classical ballet dancer, and by 16 she was dancing professionally with the Washington Ballet. Coker delayed the start of college to perform, but she ultimately earned her bachelor's degree in psychology from Columbia University, which she followed up with master's and doctorate degrees in motor science.

It was during her master's studies at Columbia that Coker sat in on a graduate seminar that changed her life. "A group of people were arguing about brains and bodies and movement," she recalls. "They were not dancers, but I thought, 'This feels so much like what I do and what I think about.' It blew my mind."

That was the moment when she realized that the "body knowledge" she'd acquired from years of dancing could be applied to movement research. "Even the phrase 'mind-body connection'—we assume that the mind and body are separate," she says. But when a person dances, "every corner of the body is illuminated in this effortful, intellectual, cognitive, creative, imaginative way."

In two intriguing studies currently underway, Coker is looking at populations on different ends of the movement spectrum, from "people who have a lot of motor experience, specifically dancers, to people who may have various disorders or differences in the way they move." For these studies, she developed a new iPhone app that collects movement metrics through its internal sensor. It allows Coker and her primary collaborator—Anat Lubetzky, an associate professor in the Department of Physical Therapy at NYU Steinhardt—to research what they call "accessible movement measurement," in other words, quantifying, outside the lab, how humans move and balance.

The first study, which has two parts, examines how balance changes as we age. Looking at two distinct populations—people under 40 and over 60—Coker assesses balance by asking each participant to attach a smartphone running her app to their midsection and complete 30 minutes of exercises under Zoom guidance. The exercises—asking subjects to stand with feet touching, stand as if on a tightrope with one foot in front of the other, or stand on just one foot, with eyes either open or closed—might sound easy, but they are not. (Just try standing on one foot with your eyes closed.)

And Coker and Lubetzky added a final cognitive variation: asking subjects to cycle through the stances while counting backward. "We know that people have more difficulty balancing with their eyes closed, no matter what the age, although the older you get, the more difficult it becomes," Coker says. "The counting exercise helps us understand what the person is prioritizing—is it their balance over a cognitive task?" The study is not yet complete, but so far it appears that if older people are

asked to stand on one foot with their eyes closed and then count backward, they will usually prioritize the motor skill—meaning they will stop counting to maintain their balance—while younger individuals are more likely to keep counting, even though they may wobble more.

A critical component of the study is to determine whether this app can be used without professional guidance over time by people of various ages at home. If so, then Coker's app could be a game changer enabling a much, much wider population—those who cannot make it into a pricey, staffed lab because, for example, their mobility is limited by Parkinson's or multiple sclerosis—to test themselves at home using the app. "It's like a thermometer," she says. "Everybody has a thermometer. By taking our own temperatures, we can get a sense of what is going on inside our bodies." So ideally clinicians could extrapolate from a patient's iPhone data to find out if something is going wrong with their balance.

"We assume that the mind and body are separate," Coker says. But when a person dances, "every corner of the body is illuminated in this cognitive, creative, imaginative way."

"We know that impaired balance is implicated in a variety of neurological disorders—Parkinson's, multiple sclerosis, Huntington's," Coker says. But so far, scientists have struggled to study people *before* they are diagnosed. With this app, individuals who take self-readings might notice their balance changing over time. "That early-warning-sign component is huge," she says.

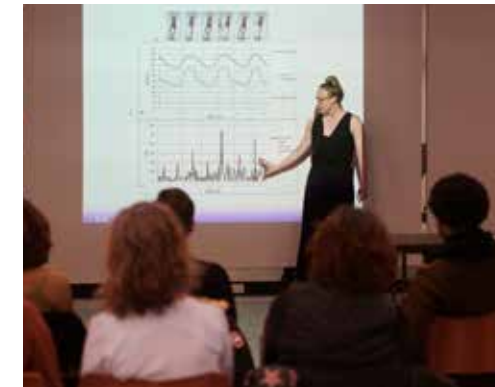
Another potential use: fall prevention. According to the CDC, each year 3 million older Americans are treated in ERs because of falls, with more than 800,000 being hospitalized, most often because of a head injury or hip fracture. And more than 95 percent of hip fractures are caused by falls. "Right now, falling in older people is a huge problem," Coker says. "But studies are focusing on predicting future falls based on *past* falls. The million-dollar question is: How do you detect or prevent the first fall? How do you know if someone is at risk?" This app could help.

The second half of this study will involve a shorter set of similar exercises done by unmonitored users (people not guided by Zoom instruction). The ultimate goal: to build a database of balance measures across the life spans of a large population. Currently, Coker says, "I can't look at a table and say, 'I'm a



Coker applies her years of dance experience to movement research.

From left: David Gonsler; Joe Carrota



ankle injury, those who've had one ankle injury, and those who've had both ankles affected. The dancers run through the usual battery of "eyes open, eyes closed, one foot down, one foot up" exercises but face two extra challenges. First, the researchers "perturb their vision" by having them wear virtual reality goggles that show them a star scape in which the stars are either unmoving or moving ever so slightly. "That visual perturbation makes it much harder to balance," Coker says. "If everything in your visual surrounding starts moving, your brain's first thought is that you're falling." In the second challenge, the dancers wear headphones and hear either no sounds or "moving" sounds; the goal is to figure out whether audio perturbation affects standing balance.

Though not yet complete, the intent is that the study's results could have important real-world applications. "A better understanding of how the brain changes in response to peripheral orthopedic injury could unlock new therapeutic approaches to injury rehabilitation," Coker says. "For example, how can we address the cortical injury response that may linger after the peripheral injury appears resolved? Some researchers are using motor imagery toward this aim, and we'd like to more thoroughly understand the mechanisms of action of these imagination-based therapies." (That, she hopes, will be the focus of an upcoming study.)

"There are some exciting—perhaps more distant—implications for our understanding of pain, fear, and reinjury anxiety as well, clinically bridging the gap between an athlete who's physically ready to return to play but may still face some psychological and functional barriers.

"There is so much we don't know about movement disorders, about aging and movement, about movement rehabilitation, about where movement resides in the brain," Coker says, summing up her work. "I find that really motivating."

ZOOM OUT

STORM SURGE

The work of a Tandon physicist may better prepare us to weather deadly storms by offering a more accurate—if bleaker—prediction of their severity. While studying the behavior of tropical cyclones, Professor Emeritus Edward Wolf found that a principle of physics called phase transition (e.g., water to vapor or vapor to water) was absent from the existing meteorological research. By applying this critical element, Wolf showed that hurricanes off Africa or any other tropical basin could be three times more destructive than their current level if water temperatures increase by two degrees Celsius—a generally accepted likelihood by the year 2100.



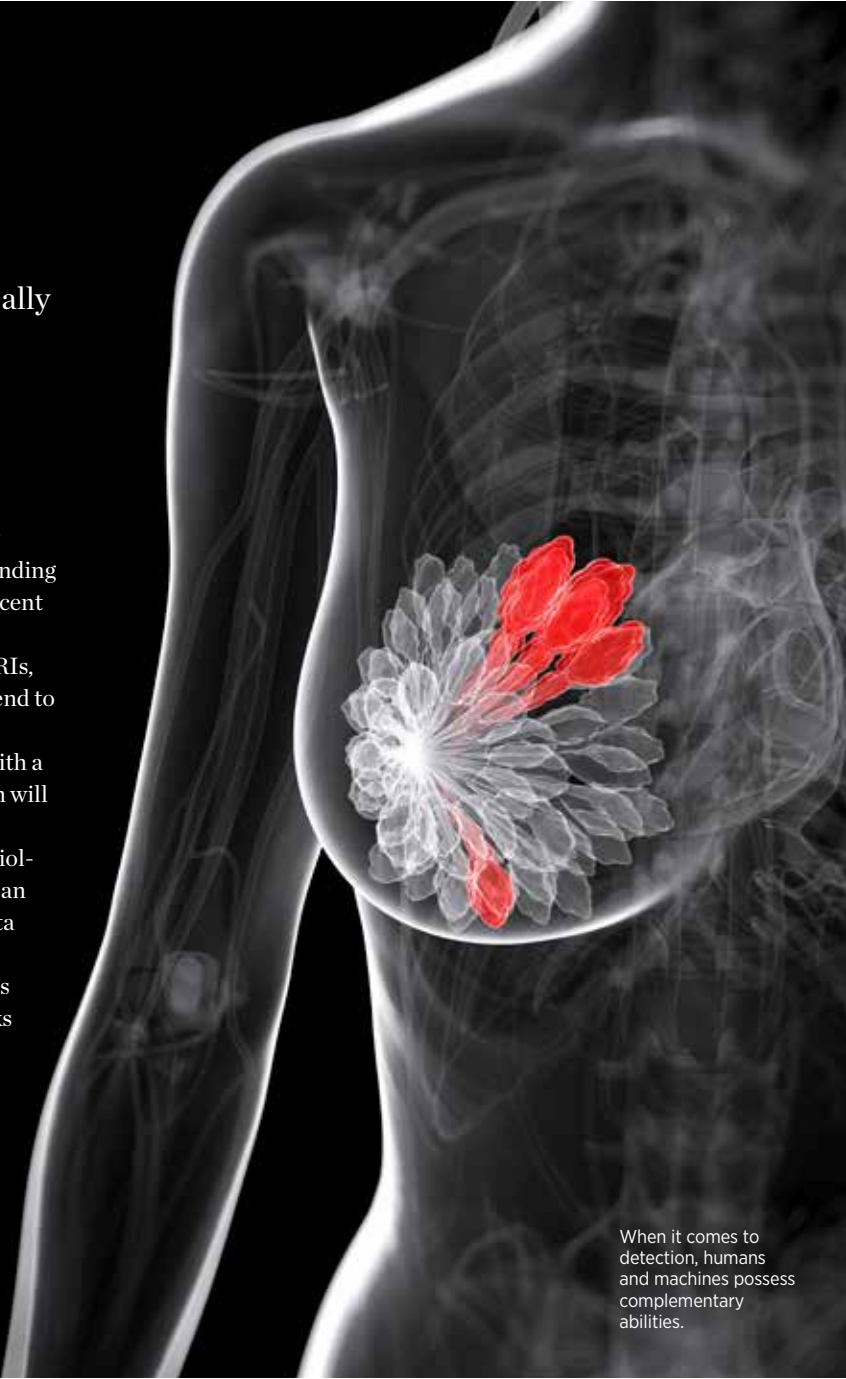
Stronger Together

Radiologists have a powerful new ally to help detect breast cancer: AI

Every year in the United States, millions of women are compressed, pulled, and mashed between the unfriendly plates of an X-ray machine, then sit on pins and needles as they await the results of their mammogram. Depending on the equipment, somewhere around 10 percent of these patients are called back for further screening—additional scans, ultrasounds, MRIs, and/or biopsies. (The newer 3-D machines tend to have clearer images so require less frequent follow-up.) Most will ultimately walk away with a clean bill of health, but some 255,000 women will be diagnosed with a malignancy.

Krzysztof Geras, assistant professor of radiology at the Grossman School of Medicine and an affiliate faculty member at the Center for Data Science as well as the Courant Institute of Mathematical Sciences, has spent much of his career training artificial intelligence networks to help radiologists with the vital act of interpreting all those medical images—as well as demonstrating that AI may one day go head to head with humans at the same diagnostic task.

Geras was already immersed in the development of deep neural networks (DNNs) when he came to NYU's Center for Data Science as a postdoc in 2016. Neural networks are trained to recognize



When it comes to detection, humans and machines possess complementary abilities.

SCIENCE/GETTY IMAGES; OPPOSITE PAGE: ELEM1/ISTOCK

patterns in the huge quantities of information they're fed so that they can mimic the human brain. To compare the cancer-detecting skills of people and machines, Geras first built an enormous data set of more than 1 million images (at least four views of the breasts from 229,426 screening exams). The radiologists' findings were typical of what they see in their patient populations: 96 percent of the cases were free of cancer, one half of one percent had a malignancy, and another 3.5 percent showed benign breast changes. Geras and his team then proceeded to teach the neural network how to make these distinctions.

What the researchers established is that humans and machines possess complementary abilities. "Radiologists are better at integrating information across different images and different imaging modalities," says Geras. "They can look at a mammogram and then they can look at maybe an ultrasound and they can look at multiple images and synthesize this information into a decision." They're also good at deciphering shapes and patterns, and they bring context, says Nan Wu, a PhD student at the Center for Data Science who joined the project five years ago. "When they're looking at a suspicious region, they might check the symmetry of the breast or the general density or maybe some other technique they've learned during their training."

"Neural networks, on the other hand, have other advantages," says Geras. "They don't get tired. They don't get bored. And they're very fast—it only takes them a small fraction of a second to process these images, and they exhaustively search for everything." In a face-off against 14 radiologists, the AI performed nearly as well as the full team and at least as well as a single radiologist.

Some 40 professors, students, and doctors have played a part in developing the system. After a few years at the Center for Data Science, Geras "realized that to make it happen I needed a bigger team." He then applied for—and received—an affiliation at the School of Medicine. "I work a lot

In a face-off against 14 radiologists, the AI performed nearly as well as the full team. But the best diagnostic results come from using both human and machine strengths.

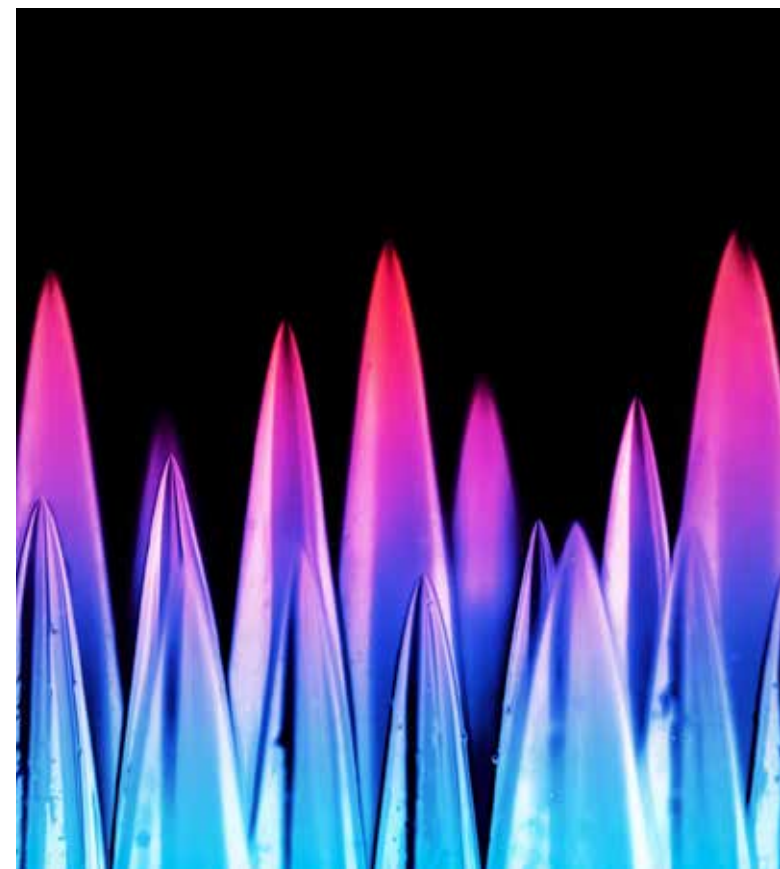
with radiologists at NYU Langone Health," Geras says. "I wouldn't be able to do this without them." His dual appointments have allowed him to gather a cross-disciplinary group of computer scientists (including from Courant), AI and DNN specialists, and experts in medical imaging (the images' creation) and radiology (their interpretation).

Geras then took the unusual step of posting a detailed report of the DNN's design technology online and offering its tools for free to universities and hospitals around the world. Institutions from Australia to Finland have downloaded the network and plugged in their own scans. "[They told me] that what we put online generalized very well to their data," Geras says. "That's a very big win for us because we have shown that these results detect cancer across different populations and different manufacturers of X-ray equipment."

By open-sourcing his research, Geras hopes that "people will have the courage to try similar projects, with other types of imaging and other body parts." Sharing the technology has also meant that "we are gaining a lot of publicity, which might help us in the future, either in terms of funding from charities, or if we ever decide to commercialize the work."

The team continues to teach the system new tricks, such as the distinctly human skill of synthesizing and interpreting multiple views of the same breast. But for now, the best diagnostic results come from a combination model that uses both human and machine strengths. Future diagnostic protocols might involve using the DNN as a "second reader," says Wu—having radiologists first estimate risk by traditional methods, then consult the network, and then possibly reassess their prediction.

Even if next-generation DNNs become more adept, she adds, the hands-on experience of doctors will help inform their design. And doctors' communication skills will always be needed to meet patients' emotional needs. "Radiologists will always be important," Wu says. "We don't really want to replace them." —Lindsay Van Gelder



Courtesy of the Applied Math Lab

Sharp Objects

How do stone forests get their spires? The answer could help improve crucial medical equipment

Stone forests—agglomerations of pointed rock formations that resemble petrified trees—have long occupied the ranks of our planet's more mysterious geological features. Scientists were stymied by the specifics of the processes that form the spear tip points of these jagged pinnacles, which can be found in Southern China, Malaysia, and Madagascar. But now a team of NYU mathematicians has solved that mystery using—of all things—a miniature mountain of candy.

Geologists agree that stone forests form when submerged rocks dissolve incrementally into the surrounding water. The researchers, who include

Leif Ristroph, an associate professor at the Courant Institute of Mathematical Sciences, and Jinzi Mac Huang, an assistant professor of mathematics at NYU Shanghai, conducted a series of experiments in the Applied Mathematics Lab to investigate how dissolution drives the specific creation of the forests' trademark spikes. Using computer simulations, they developed a math model that isolated the precise dissolution mechanisms that culminated in the structures' sharp spires. They found that as the minerals in the rock dissolved, the surrounding water got heavier and flowed downward thanks to gravity, modifying the dissolution rate and leading over time to those dramatic tapers. To confirm the accuracy of the model, the team replicated the formation of stone forests by submerging blocks of soluble hard candy in water tanks and observing the dissolution process that reshaped them. As they'd hoped, the resulting "candy forests" (pictured at left) sprouted points that could break skin.

Published in *Proceedings of the National Academy of Sciences*, the research has both practical and theoretical implications. "We are considering manufacturing sharp-tipped objects through dissolution," says Huang. "Our work actually shows that we can control the final sharpness of this object through a carefully designed initial shape." Such precise control could improve the manufacturing standards of needle-tipped elements used in crucial medical and research equipment.

Beyond that, however, lies the satisfaction inherent in understanding the world a little better; the shape of a natural object is, after all, an important clue to its history. "Our progress not only extended the frontier of the study of fluid-structure interactions," Huang says. "It also brought us one step closer to understanding the past, and the future, of the rocks on our planet." —Abhimanyu Das

MORE ON THE
WEB

Watch the lab's "candy forest" sprout its spikes at nyu.edu/scope/stoneforests

Out for Justice

Law professor Alina Das takes aim at America's racist immigration policies

Alina Das's interest in immigration law was borne of personal experience. Her parents immigrated to the US from India, and Das says: "I always had this sense of otherness, a feeling that because of the color of my skin, because of differences in culture and upbringing, I was never fully perceived as an American." In her book *No Justice in the Shadows*, Das—School of Law professor and codirector of NYU's Immigrant Rights Clinic—explores the racist roots of US immigration policy and how the criminal legal system is used to target immigrants.

Immigration law has always been influenced by racism and white supremacy

"Congress's first act in 1790 was to limit the right to be naturalized to free, White persons. And from there, you see that concept turn up whenever it appears that people of color may develop a foothold. When Chinese immigrants were developing roots in California, legislators talked about Chinese women as prostitutes. One of the first antidrug ordinances in the country was a San Francisco anti-opium law clearly targeting Chinese people. Fast-forward a few years, and Congress passes the Chinese Exclusion Act."

The Trump administration was "a magnifying glass for what was already happening"

"More people were deported in Obama's first three years than in Trump's. Obama defended it by talking about deporting felons, not families. So he used this language of criminality, saying that we are going after the 'right' people. [But] Trump targeted people who'd previously had some measure of security, with attacks on Deferred Action for Childhood Arrivals, and of course the family separation program. The openly racist

statements Trump made to justify these policies made it much clearer what was happening."

Deportation is a shortcut that doesn't actually solve the problem

"The Trump administration used [the gang] MS-13 as its favorite talking point. But when people [previously] came to the US fleeing Central American conflicts, the Reagan administration didn't recognize them as refugees because of its political ties to regimes in these countries. So those immigrants were not given support. Many were victimized and formed a gang to protect themselves. And instead of actually doing the real work to address gang issues, which has to do with gang intervention programs, education, economic opportunities, we decided to deport people. That's how MS-13 became a transnational gang. If you're deporting somebody who is committing violence without doing the work of addressing that violence, all you're doing is spreading violence."

Things are much the same under the Biden administration

"Much of the same harm is being done, but it comes with the veneer of legitimacy that the Trump administration didn't even bother trying to adopt. We don't have to talk about it because it's not in our face and not being justified using the overtly racist terms that Trump did."

The solution is to ensure that the criminal legal system isn't used as a pipeline for deportation

"In my work, I see people who are American in every way, except on paper, being told they have to start over in a country where they may face persecution or at minimum be placed into forced, isolated poverty because they know no one. [Even those who commit crimes] don't lose their humanity because of their worst choices. We are choosing to harm people in very drastic and cruel ways that really don't provide any good. It doesn't reverse the loss; it creates a ripple effect of harm."

—Lisa Armstrong

"Congress's first act in 1790 was to limit the right to be naturalized to free, White persons. And from there, that concept turns up whenever it appears that people of color may develop a foothold."

MORE ON THE WEB

Watch Das discuss her career in immigration law at nyu.edu/scope/alinadas



Das started as a student in NYU Law's Immigrant Rights Clinic, which she now codirects.

Courtesy of NYU Law

Delivery Drones

How Robotics Lab engineers are holding sway over unwieldy cargo



Ever wonder how delivery drones handle swinging payloads that dwarf their spindly frames without spinning out of control? Until now, not reliably! Luckily, Giuseppe Loianno and his team at NYU's Agile Robotics and Perception Lab are on it. "Previous approaches leverage GPS or motion capture and do not consider

perception and physical constraints," Loianno says of the current crop of drones. "This approach can be reliable in remote areas but is subject to strong failures in urban environments where the signal is often shadowed. In addition, many systems consider the payload a disturbance."

If it seems counterintuitive categorizing the cargo as an obstacle to the workings of a cargo delivery system, the robotics team agrees. The payload is, in fact, key to the researchers' approach; it's the heart of what Loianno calls "a perception and action system." An onboard camera watches how the dangling payload is moving while an inertial measurement unit—a device like the one in your phone that measures acceleration and rotation—tracks how the drone itself is moving. These data sets work with a model predictive control system that anticipates what the payload will do next and how that squares (or doesn't) with what the drone itself is about to do, ensuring that the physics of these elements remain synced in service of stability. "The user should imagine that that payload has its own motion or path in space," explains Loianno, an assistant professor at Tandon. "The robot moves to accommodate the load's motion."

The system has shown promising results in preliminary tests but is still a ways from wide deployment. Challenges include adjusting for extreme speed and weather as well as complications operating in GPS-denied environments. The team is currently working on a distributed approach involving multiple drones cooperatively managing payloads, with initial runs already showing exciting results. The project has ramifications beyond simply protecting your Amazon packages. Drones could streamline warehouse operations, transform object manipulation on construction sites, and even revolutionize supply deliveries in disaster zones. The sky is literally the limit.

Bestgreenscreen/istock; opposite page: UIU/istock

IN FOCUS

ON THE WATERFRONT

For a group of Gallatin undergrads, the world was their oyster in fall 2020 thanks to environmental science researcher Karen Holmberg's course NYC Coastlines: Past, Present, and Future. The River Project, which is part of the Hudson River Park Trust, suffered from a pandemic-related shortage of volunteers, and the students were invited to collect oyster monitoring data—becoming the only citizen scientists to do so for the project's entire season. By measuring and weighing the living oysters, which are on wire meshes attached to pier pilings and tagged with a number, the students took part in determining the health of the Hudson River.



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*In This
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Kaleidoscopic crystalline
insecticides—with a
bizarre backstory

