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MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ SEPTEMBER 21, 2013

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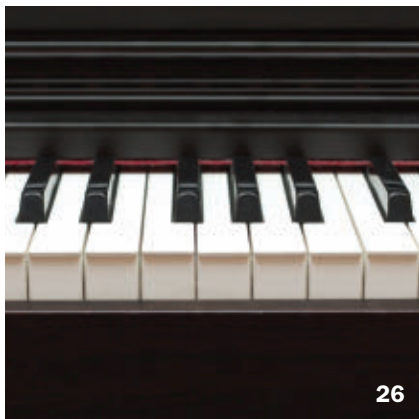
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COVER Death by window collision claims millions of birds each year, including these collected in Washington, D.C. Scientists aim to prevent such deaths.
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FROM THE EDITOR

Saving birds may require seeing things their way



Birds are no dummies, as *Science News* has reported (*SN: 8/29/09, p. 5*). And yet, huge numbers of them regularly collide with windows, sometimes fatally. In fact, the best estimate (which is admittedly very rough) suggests these collisions kill millions of birds a year. And as architects and builders increasingly incorporate massive expanses of light-giving windows into homes and skyscrapers, it seems like the problem is poised to get worse.

The problem, as life sciences writer Susan Milius explains on Page 20, appears to be an issue of how birds perceive the world, not one of brainpower. Birds often don't detect glass at all, or worse yet see a reflection of the landscape behind them and surmise a depth ahead that's not there.

There are some issues of bird anatomy as well. Birds generally see a much wider field of view than humans, but many can't see that well straight ahead and may even have a blind spot right ahead of them as they fly.

Birds do see in ultraviolet wavelengths that people can't detect, which may offer one solution to those seeking to design bird-friendly windows. Scientists have also shown that simple patterns of stripes on windows help birds see that there's a solid surface there. Unfortunately, the stripes also tend to block people's views. Still, researchers are hopeful that with enough effort and public support, buildings will eventually be built with windows that birds can see and people can't.

Bird perception of another kind is highlighted in an intriguing story on Page 9, which posits that some birds get a sense of a busy road's speed limit and time their escapes from oncoming cars thusly. A problem arises for these birds when people speed, which may not leave enough time to fly away.

Bird strikes and road kills may prove difficult to eliminate until we more fully understand how birds perceive their environment. That's a tall order, considering how much we still have to learn about how humans experience the world. A story by Laura Sanders on Page 13 raises one intriguing mystery: The brains of children who spent their first few years in orphanages staffed by people of one race react differently to faces of other races compared with kids who were born into more diverse environments. What that means, or how it may affect their coming of age in Los Angeles (where the study was conducted), is completely unknown.

—Eva Emerson, Editor in Chief

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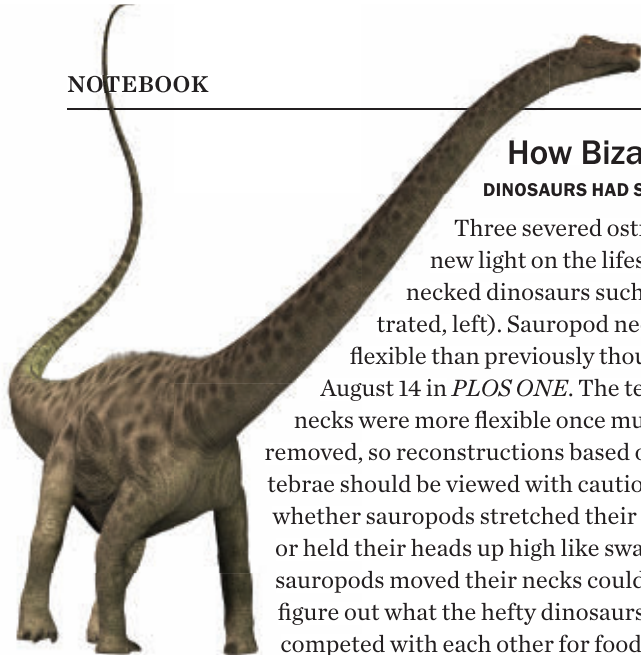
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How Bizarre

DINOSAURS HAD STIFF NECKS

Three severed ostrich necks have shed new light on the lifestyle of sauropods, long-necked dinosaurs such as *Diplodocus* (illustrated, left). Sauropod necks were probably less flexible than previously thought, researchers suggest August 14 in *PLOS ONE*. The team found that ostrich necks were more flexible once muscles and tendons were removed, so reconstructions based only on fossilized vertebrae should be viewed with caution. It remains unclear whether sauropods stretched their necks out horizontally or held their heads up high like swans. Understanding how sauropods moved their necks could help paleontologists figure out what the hefty dinosaurs ate and which species competed with each other for food. — *Cristy Gelling*



50 Years Ago

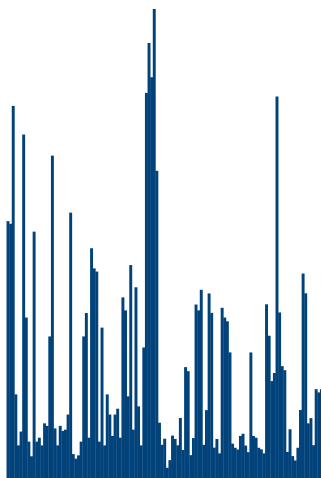
Excerpt from the September 21, 1963, issue of *Science News Letter*

GRAIN ALCOHOL IN GASOLINE? The prospect of burning up the country's grain surplus in automobile motors is enticing to wheat belt congressmen. However, to petroleum experts ... the idea is just an exhaust pipe dream. The chemists take a dim view of a bill ... that would require all gasoline to contain at least five percent grain alcohol.... Dr. J.O. Clayton, a petroleum chemist for California Research Corporation, San Francisco explained ... when alcohol is needed in gasoline, it is much easier and cheaper to use synthetic alcohol and not bother with grain.... "If the bill ever passed," he added, "it might encourage farmers to grow more grain instead of less, and we would still be left with a surplus."

UPDATE: The wheat congressmen's bill didn't become law. But grain alcohol, or ethanol, eventually ended up in the nation's fuel supply. About 40 percent of the U.S. corn crop is now used to produce the ethanol that is blended with gasoline to fuel vehicles. American farmers planted more than 97 million acres of corn in 2013, up from about 69 million acres in 1963-64.

Say What? | BURSTINESS \BER-stee-nehs\ n.

The inclination of a system to send spurts of rapid-fire messages. A bursty system does not send information in a slow and steady drip. Instead, it will suddenly turn on a powerful jet and then go dry again (illustrated, right). Historically, the term has been used in network sciences to describe the flow of information in particular systems. Now "burstiness" is trickling into the parlance of neuroscientists, too. In the brain, burstiness describes the propensity of neurons to send off machine-gun sprays of messages. Researchers are studying how neuron burstiness relates to complicated brain tasks like paying attention. — *Laura Sanders*



Science Stats | LYME DISEASE

Combining data from health insurers, testing laboratories and surveys, the U.S. Centers for Disease Control and Prevention now has a clearer picture of the number of U.S. Lyme disease cases diagnosed each year. Lyme is the most common tickborne illness in the United States.

States that report 96 percent of Lyme cases

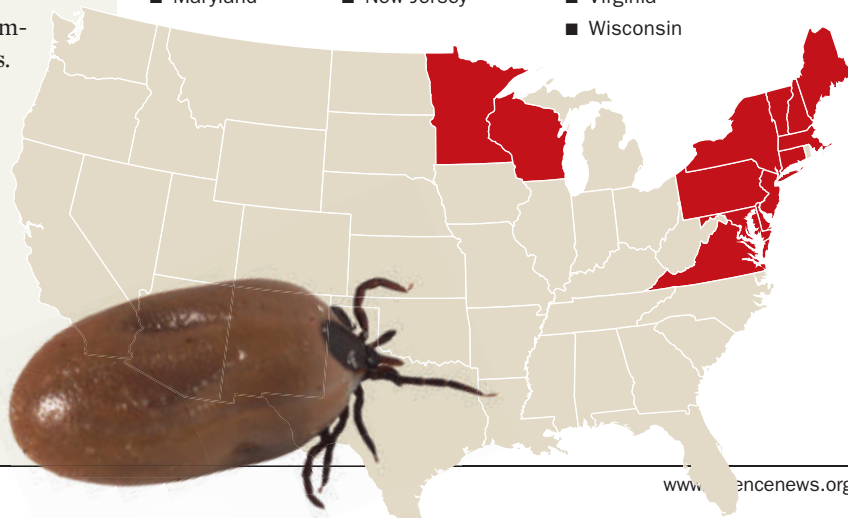
- Connecticut
- Delaware
- Maine
- Maryland
- Massachusetts
- Minnesota
- New Hampshire
- New Jersey
- New York
- Pennsylvania
- Vermont
- Virginia
- Wisconsin

30,000

Previous estimated number of Lyme disease diagnoses each year, based on reports to CDC

300,000

New CDC estimate of number of Lyme disease diagnoses each year



“ When you read this article, you think, ‘Why hasn’t anyone done this before?’ It’s a simple idea, but it has such a large impact. ”

—RAINER ADELUNG, PAGE 8

Technology Strong Tinkertoy-like scaffolds

Life Birds know road speed limits

Health & Illness Malaria vaccine progress

Mind & Brain Blood may foretell suicide
Caffeine affects mouse’s growing brain

Earth Crescent-shaped dunes confound

Humans Personality disorder ignored

In the News

STORY ONE

Tiny human almost-brains made in lab

Stem cells arrange themselves into patchwork of neural tissue

By Laura Sanders

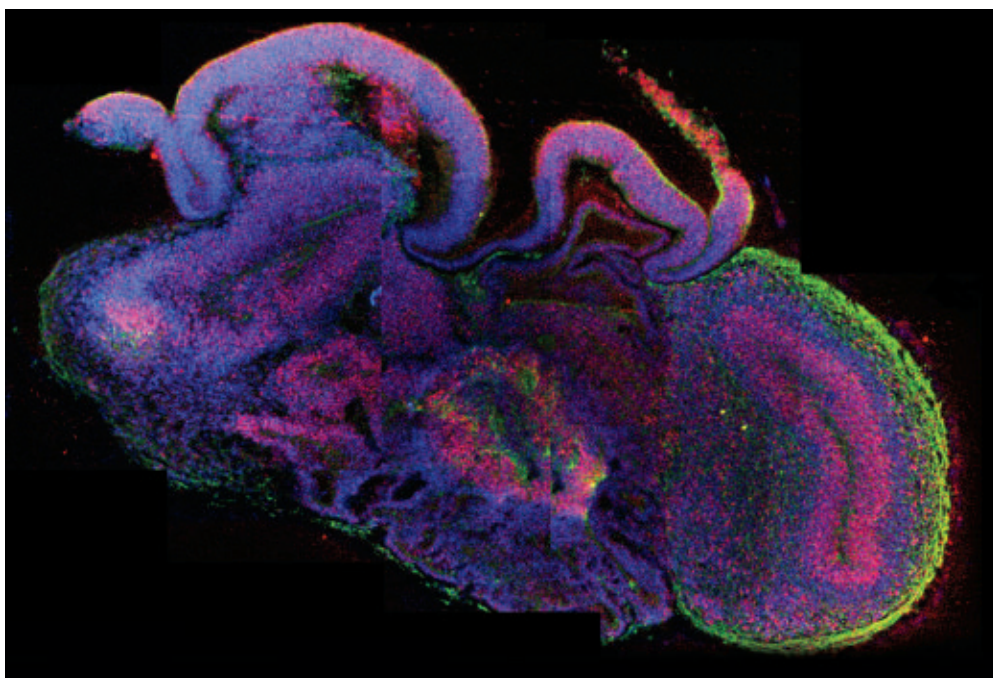
Largely left to their own devices, human stem cells knitted themselves into tissue with a multitude of brain structures and specialized cadres of neurons. The cells took on a form reminiscent of the brain of a 9-week-old fetus, scientists report August 28 in *Nature*.

The tissue, dubbed a cerebral organoid, doesn’t approach the dizzying complexity of the human brain. Yet these tiny neural balls, each no bigger than a BB pellet, represent the most complex brain structure grown in a lab to date, researchers say.

“They’ve done something very remarkable,” says neuroscientist Flora Vaccarino of Yale University.

After about two months of growing in a nutrient broth, the cells had specialized into distinct, recognizable parts of a developing brain. The organoid grew structures similar to a human brain’s hippocampus, retina and choroid plexus, which produces cerebrospinal fluid in the brain.

The cerebral organoids also developed discrete parts of the cerebral cortex, the outer sheet of the human brain that’s responsible for advanced



In cross section, a lab-grown approximation of an immature human brain reveals neurons (green) and neuron-producing stem cells (red).

thought processes.

The lab-grown tissues showed other brainlike features: Many of the neurons were actively firing off electrical messages, experiments revealed. Select groups of young neurons seemed to have migrated to distinct regions of the organoid, mirroring a process that helps distribute neurons throughout a young brain.

And like the brain, the organoids had rich populations of a specialized cell type called radial glial stem cells. These cells kept neuron numbers growing.

Coauthors Madeline Lancaster and Jürgen Knoblich of the Austrian Academy of Science in Vienna say the tiny lab-grown tissues could have big implications for brain science. Already, by

growing a personalized organoid with cells from a patient, the researchers have learned about microcephaly, a developmental disorder marked by a small brain.

“There is enormous potential there,” says neuroscientist Ed Lein of the Allen Institute for Brain Science in Seattle.

The organoid-growing process began with human stem cells, taken either directly from an embryo or from adult skin samples that had been reprogrammed to an embryo-like state. These cells can grow into any tissue in the human body. To make them into a cerebral organoid, the researchers let the cells grow for a few days in a dish, and then moved them into a broth that encourages the growth of neuroectoderm tissue, the kind that

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ultimately creates the brain. After that, the researchers injected these cells into a drop of gel that serves as a scaffold for the cells to grow on. In the final move, the gel droplets were transferred to spinning flasks that held nutrients.

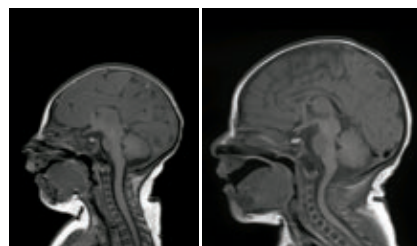
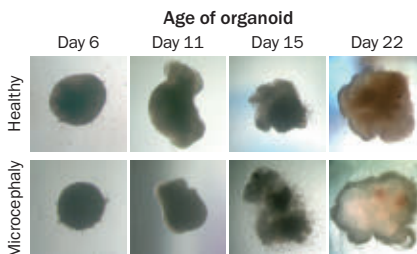
This last step was crucial, the researchers found: The spinning motion distributed oxygen and nutrients to all of the cells in the organoid. Without it, cells, especially those in the center, would starve and die.

After about two months, the organoids had pushed past the boundaries of their gel droplets, reaching a diameter of about 4 millimeters. Studies then revealed the organoids' nascent brain-like anatomy and activity.

So far, the researchers have grown hundreds of these cerebral organoids. The oldest is about a year old. In the elderly organoids, the cells are still alive but have stopped dividing, Lancaster says. The organoids reach maximum size after about two months; even then, some of the cells on the interior don't get enough nutrients and oxygen.

One of the most remarkable aspects of the work is that the organoids formed the complex, brainlike structures with little coaxing from researchers, Lein says. "The biggest thing for me is realizing that most of the information for

Clues to microcephaly



Personalized organoid Microcephaly results in a small brain (bottom left) at birth (bottom right shows normal brain). A cerebral organoid from a microcephalic patient's cells (top, lower row) was also smaller than one grown from healthy cells (upper row).

generating a brain is intrinsic," he says. "These cells carry enough information to generate a brain."

That means that cells from different people can easily be used to grow very different sorts of brains. As part of their study, Lancaster, Knoblich and colleagues grew personalized organoids using cells from the skin of a patient with microcephaly caused by mutations in a


known gene. Lancaster says she immediately saw that the organoids were smaller than usual.

Microcephaly has been difficult to study. But with the microcephalic organoid, the researchers may have figured out why microcephalic brains are smaller. Neuron-producing radial glial cells were stopping their job too early and disappearing, the researchers found. This early termination could ultimately result in too few neurons, a situation that might also happen in microcephaly. By adding a working copy of the faulty gene, researchers were able to repair the damage. These patched-up stem cells grew an organoid with more radial glial cells.

Organoids could also offer insight into more complex disorders rooted in brain development, such as schizophrenia and autism, Knoblich says.

Still, these organoids differ from the brain in many ways. Unlike the brain's organized structure, for example, regions in the organoids arrange themselves haphazardly. The neurons make connections, but not necessarily meaningful ones. And important support systems such as blood vessels are absent.

"If you look at our organoid as a whole, it is not a brain," Knoblich says. Nonetheless, he says, the system is a useful approximation. ■



Back Story | DOES IT DREAM?

A newly created cerebral organoid may be the most sophisticated model of the brain created so far, but it's still a rough approximation of the real thing, lacking some of the key features that enable sensations, thoughts and memories. These tiny blobs aren't full-fledged brains, spinning in flasks and wondering about the meaning of life.

Existential musings aside, these organoids may prove exceedingly useful for research. A growing organoid could offer a window into the development of the human brain and a way to study disorders that arise when things go wrong early in this process. Scientists can tweak organoids' genes, making it possible to study harmful human mutations. And instead of relying on imperfect animal models to screen drugs' effects, scientists could test drugs on organoids. —*Laura Sanders*

FROM TOP: M.A. LANCASTER ET AL./NATURE 2013; TONY LATHAM/GETTY IMAGES



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X-shaped blocks form strong lattice

Millions of the identical parts could be used in big structures

By Meghan Rosen

A carbon-fiber skeleton of Tinkertoy-like building blocks is 10 times as stiff as structures of similar densities. And because the framework is made of mostly identical pieces, broken parts can easily be swapped out for new ones, its inventors report in the Aug. 16 *Science*. The new design could one day form light, stiff, easy-to-repair frameworks for airplanes, bicycles, bridges and even buildings.

“It’s fascinating,” says materials scientist Rainer Adelung of Kiel University in Germany. “When you read this article, you think, ‘Why hasn’t anyone done this before?’ It’s a simple idea, but it has such a large impact.”

For years, fancy bicycles and luxury cars have used glued-together carbon fibers, called composites, to trim weight from their frames without compromising strength. Now, manufacturers are starting to craft huge sections of airplanes in single swaths of the lightweight materials. Fewer parts means fewer joints, which tend to be heavy and tricky to fix.

That has driven manufacturers to work with even bigger plane pieces. In 2008 Spirit AeroSystems, a manufacturer that makes parts for Boeing and Airbus, came to MIT materials engineer Kenneth Cheung and his lab leader, Neil Gershenfeld, with a wild idea: What if they could 3-D print an entire plane in one gigantic piece?

Cheung and Gershenfeld had doubts. Though a giant piece of composite has fewer joints, it can be hard to repair, Cheung says. When composites break, they break big-time. A wallop violent enough to crack a composite part in one place has a domino effect. The energy of the crash rebounds through the part, busting it in multiple places.

So Cheung and Gershenfeld came up with an idea to assemble a plane out of millions of identical pieces, rather than one enormous one.

Cheung played with several designs, slicing shapes out of cardboard and plywood before settling on the repeatable unit: a flat “X” of carbon-fiber composite, with a hole in the center and a loop at the end of each arm. The unit is 2 inches long, Cheung says, but could scale to virtually any size. “You can think of it as a really high-performing Lego,” he says.

Cheung hooked the Xs together to make cube-shaped lattices of repeating triangular pyramids and then crushed the structures to measure their strength and stiffness. A cube 8 inches on a side and about as heavy as an egg could hold more than 650 pounds before crumpling, Cheung says. And given the material’s very low weight, Adelung says, the lattice is “remarkably stiff.”

The geometry of the cube’s lattice is a key part of its stiffness and strength. “If you built a bunch of triangular pyramids out of toothpicks and marshmallows, you could probably rest a book on top,” Cheung says.

When his and Gershenfeld’s composite structures hit the breaking point, individual pieces in the lattice snapped, confining breaks to discrete spots. This property would give manufacturers structural damage control. “You could incrementally replace single parts, knowing that the structure is completely stable while going through that process,” Cheung says. He envisions using robots to build

the structures and crawl through them, inspecting parts and switching out cracked pieces.

The researchers also tinkered with the structures’ flexibility by plugging thinner, more bendable pieces into the lattice. By fitting these pieces into specific parts of the lattice, the researchers could force certain areas to buckle while keeping other areas rigid. In an airplane, this type of design could let pilots maneuver their crafts by flexing the wings instead of lifting and lowering flaps.

The structures don’t come close to rivaling the strength and stiffness of denser materials, says James Tour, a materials chemist at Rice University in Houston. But they’re incredibly lightweight — and for cars, planes and spacecraft, he says, “weight is a huge, huge concern.”

In September, Cheung will join NASA in a project to craft lattices for structures in space. ■

A load-testing machine revealed that lattices of X-shaped carbon-fiber pieces can withstand forces far out of proportion to their weight.



IMAGE © CC-BY-NC-SA K.C. CHEUNG

Life

Antarctic unsavory to shipworms

Currents and polar front keep destructive mollusks at bay

By Susan Milius

Quirks of ocean currents may have turned the waters around Antarctica into a rare sanctuary for wooden shipwrecks, free of the destructive mollusks known as shipworms.

A front formed by the junction of frigid polar and warmer waters as well as a strong current circling the continent may block tiny shipworm youngsters from moving in, says Thomas Dahlgren of Uni Research, the University of Bergen's partner research company in Norway.

Fourteen months after leaving wooden planks and whale bones underwater on western Antarctica's continental shelf, researchers found no evidence of

wood-boring mollusks. Whale remains attracted bone-eating worms but the wood emerged "pristine," Dahlgren and his colleagues report August 14 in the *Proceedings of the Royal Society B*.

Offshore Antarctica is a terrible habitat for wood borers because the continent probably hasn't grown trees for at least 30 million years. And research on other marine species has suggested that the Antarctic circumpolar current and the polar front can block some invaders from moving in.

If more exploration confirms the dearth of wood-boring mollusks, Antarctica would join the Black and Baltic seas as the main gaps in the world's shipworm map—for now. "Invasive shipworms are now entering the Baltic and may well

A study in Antarctic waters turned up a new species of worm, *Osedax antarcticus*, that feeds on the bones of dead whales.

be threatening ancient shipwrecks," says Janet Voight, a curator at the Field Museum of Natural History in Chicago.

Sea-sunken timber can attract mollusks called teredinids, with long wormy bodies sticking out of shells, and the more depth-loving xylophagans. These deeper-dwelling wood-borers live much like the *Osedax* worms that bore into whale bones on the ocean floor, says marine evolutionary biologist Kenneth Halanych of Auburn University in Alabama.

The submerged whale bones attracted *Osedax* worms. At least two kinds are species new to science, apparently relying on microbes to extract nutrients from fallen carcasses. ■

Birds gauge speed limits

Average rate, not each car's speed, guides when to flee

By Susan Milius

Highway-savvy birds don't read road signs, but they may pay more attention to speed limits than some human drivers do.

As a car roars toward birds standing on the asphalt, they don't check the driver's exact speed when judging how soon to flap out of the way, says behavioral ecologist Pierre Legagneux of the University of Quebec in Rimouski.

Instead, the speed limit on the road is a better predictor of how close a car gets before a bird startles into the air, he and Simon Ducatez of McGill University in Montreal report August 21 in *Biology Letters*.

The project opens up evolutionary

questions, he says. Legagneux looks forward to untangling how much birds' behavior comes from learning the average speed along a road and how much from the evolutionary force of selection as cars kill off birds that fail to get out of the way.

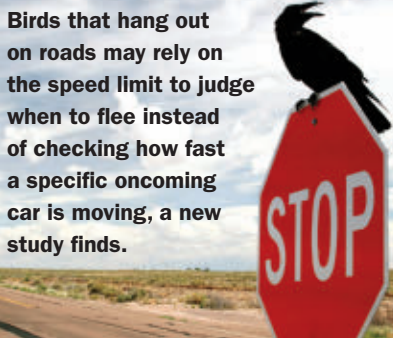
Others have studied how close a human can get before animals flee, called the flight initiation distance. Yet Legagneux says that as far as he knows, this is the first study to analyze the distance between road birds and approaching cars.

He started collecting the data to

enliven his drive home from the lab when he worked in western France. His total of 134 measurements included 21 species, but more than half came from three: carrion crows, house sparrows and Eurasian blackbirds.

Whether Legagneux drove faster than the speed limit or slower proved less important than the speed limit itself. On stretches of road with a speed limit of 20 kilometers per hour, birds waited to fly until the car was about 10 meters away. That distance increased to roughly 25 meters on roads with a 90-kph limit and around 75 meters at a 110-kph limit.

Animals can become quite sensitive to the quirks of human activity, says behavioral ecologist Ted Stankowich of California State University, Long Beach. When studying what spooks black-tailed deer, he could walk within six feet of deer familiar with humans as long as he stayed on a road. At greater distances though, "if you take one step off the road, they'll run away," he says. "It's all about context." ■



Birds that hang out on roads may rely on the speed limit to judge when to flee instead of checking how fast a specific oncoming car is moving, a new study finds.

Health & Illness

Malaria vaccine a hit in early test

Inactivated parasite provokes effective immune response

By Nathan Seppa

The long, bumpy path to a malaria vaccine may have hit a smooth stretch as an early-stage study finds that multiple injections with inactivated malaria parasites can protect against the disease.

The study was small, and the vaccine required five intravenously delivered doses to work, which would be an obstacle for teams attempting mass vaccination in developing countries. Also, the shots were tested in adults, not children, who are the prime victims of malaria.

Still, the study offers decidedly good news, says Anthony Fauci, director of the National Institute of Allergy and Infectious Diseases in Bethesda, Md., which sponsored the research. “This is an important advance,” he says, noting that the vaccine induces an immune onslaught that kills the malaria parasite in its infective sporozoite stage. That means uninfected mosquitoes that bite a vaccinated person don’t get

infected, slowing the disease’s spread.

Researchers gave four or five shots to 15 volunteers over several months. The volunteers were then bitten repeatedly by malarial mosquitoes. A few weeks later, 12 had no disease, including all six who got the full five doses, the researchers report August 8 in *Science*. All but one of the unvaccinated volunteers got sick and received treatment promptly.

Scientists already knew that weakened versions of malaria sporozoites could induce immunity in people. To weaken sporozoites for a vaccine, researchers irradiated infected mosquitoes, damaging the parasites inside them. Then the researchers used the damaged parasites to elicit an immune response in people. The team mastered the delicate task, attenuating the parasites just enough so that they don’t cause disease, but still trigger an immune response that can kill any full-strength sporozoites introduced by subsequent mosquito bites.

The researchers also effectively delivered the vaccine into volunteers, albeit with IV injections. In earlier tests, this vaccine failed to gin up adequate immunity when given by shots into

the skin, which are easier to deliver.

“This is the first step toward success with this approach,” says Denise Doolan, a molecular immunologist at the Queensland Institute of Medical Research in Herston, Australia. “It has taken enormous dedication and perseverance to achieve this result.”

“This is the first step towards success with this approach.”

DENISE DOOLAN

Coauthor Robert Seder, a physician and immunologist at NIAID, says the research team plans to test the vaccine in more people and find out how long the protection lasts. A field

trial is planned in Tanzania.

Doolan says that developing a regimen of simpler and fewer doses would “have a dramatic impact on public health.”

Meanwhile, Seder says, the IV vaccine — if fully tested and approved — might still be useful for protecting health officials, military forces and travelers. Fauci cautions that while this vaccine showed effectiveness against one strain of *Plasmodium falciparum*, the parasite that causes the most severe kind of malaria, the vaccine still has to prove itself against other *P. falciparum* strains.

Another experimental malaria vaccine has been shown to be partially protective in children. ■

Flu immunity prompted, years later

Work could help make more effective influenza vaccines

By Tina Hesman Saey

Exposure to new flu strains can stimulate production of antibodies that could protect against older versions of the virus, researchers have found. The work suggests how to make longer-lasting vaccines with broader flu-fighting capabilities.

Scientists had suspected that the immune system could draw on prior experience to craft potent protection against new strains of flu. But there was no evidence, says Patrick Wilson, an immu-

nologist at the University of Chicago.

Peter Palese of the Icahn School of Medicine at Mount Sinai in New York City and colleagues report in the Aug. 14 *Science Translational Medicine* measurements of antibodies in blood samples drawn from 40 people who were born between 1917 and 1952 and lived through the flu pandemics that struck in 1957, 1968 and 1977. The participants volunteered blood samples at five-year intervals between 1987 and 2008.

Over time, antibodies against the

pandemic strains rose as the people encountered new versions of the flu, the team discovered. But when faced with an unchanging virus called cytomegalovirus, the study participants’ antibodies didn’t climb, suggesting that new virus varieties are important for prodding production of old antibodies.

The work also suggests which parts of the virus provoke the best antibodies. Antibodies that can fight the widest range of flu viruses are those that latch onto the stalk portion of the hemagglutinin protein, a molecule on the flu’s outer coat. The stalk doesn’t change much from flu virus to flu virus, making it an attractive vaccine candidate. [ⓘ](#)

“We suspect asthma is a protective response against fungi.” —DAVID CORRY

Clues emerge to allergic asthma

Implicated enzymes chop up a blood-clotting protein

By Nathan Seppa

A common blood-clotting protein turns out to play a role in allergic asthma. The protein interacts with better-known immune system players, providing a missing piece of the biological puzzle underlying such respiratory attacks. The finding exposes a biological chain of events that could offer targets for allergic asthma treatments, researchers say.

Asthma triggered by allergies is marked by inflammation of the respiratory tract, which leaves a person gasping for breath, coughing and wheezing. There are many players in this over-

reaction, including an immune protein called TLR4, or toll-like receptor 4, and enzymes called proteinases in allergens.

In the study, a team of scientists exposed mice to proteinases from molds, which are common fungal allergens. These proteinases break down a blood-clotting protein called fibrinogen. The resulting shards of fibrinogen then bind to and activate TLR4, a receptor protein found on immune cells and other cells lining the airways. That triggers inflammation—the hallmark of allergic asthma, the researchers report in the Aug. 16 *Science*.

Further tests indicated that this fibrinogen cleaving inhibited fungal infection in the mice, says study co-author David Corry, an immunologist and pulmonologist at Baylor College of Medicine in Houston. “We suspect asthma is a protective response against fungi” in many people, he says. But in others, “it’s an aberrant response induced by

extreme sensitivity to the proteinases.”

When the researchers prevented fibrinogen breakdown, the mice had a reduced reaction to mold spores. The same thing happened in mice lacking TLR4, suggesting that both proteins are part of a protective biological chain of events that goes awry. The precise chunk of disassembled fibrinogen responsible for this chain reaction is unknown.

“The fibrinogen finding makes perfect sense,” says Stephanie Eisenbarth, a physician and immunologist at Yale University. “Fibrinogen may be a canary in a coal mine—acting as a detector of something pathogenic,” she says.

Corry says the somewhat primitive TLR4 pathway “is only half the story.” Many scientists maintain that allergy results only when another side of defense called adaptive immunity runs amok. That involves more sophisticated immune warriors called T and B cells. ■



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Mind & Brain



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Caffeine shakes up growing brain

Mice exposed before birth show memory deficits

By Laura Sanders

Pregnant mice buzzed on caffeine gave birth to pups with brain changes and lasting memory deficits, a new study shows. The results, published August 7 in *Science Translational Medicine*, leave unclear whether caffeine causes a similar effect in people.

The study convincingly shows that caffeine changes the brains of exposed pups, says child neurologist Barry Kosofsky of Weill Cornell Medical College in New York. But he cautions that mouse and human brains develop very differently, so direct comparisons are impossible. The study has no immediate message for pregnant women, Kosofsky says. “We are totally at a loss about what to say for caffeine.”

For a mouse mother, though, the

experiment’s story is clearer: Moderate caffeine intake during pregnancy changes baby brains, and not for the better.

While pregnant and later lactating, mice drank water laced with caffeine in an amount comparable to a person drinking three to four cups of coffee a day. In offspring, cells in a memory center in the brain called the hippocampus fired off too many messages, a behavior that could lead to seizures, Carla Silva of the French National Institute of Health and Medical Research and the University of Coimbra in Portugal and colleagues found.

As adults, the caffeine-exposed mice performed worse than nonexposed mice on memory tests. Usually, mice ignore familiar objects and spend lots of time investigating something new. But mice exposed to caffeine during development showed no such preference, suggesting that they couldn’t remember which object was new. What’s more, these mice had fewer neurons in parts of the hippocampus than normal mice.

“We are totally at a loss about what to say for caffeine.”

BARRY KOSOFSKY

These problems might be explained by another deficit the researchers uncovered. As brains form, some neurons must migrate great distances to reach their final home. This journey, which happens in the second half of pregnancy in mice, was disrupted in pups born to caffeine-

ated mothers: New neurons traveling to a specific part of the hippocampus reached their final destinations later in those mice than in unexposed mice.

Neurons in monkeys, and probably people, undergo a journey, too, but the timing is very different, Silva says. In primates, the bulk of this migration takes place after birth, which may mean that caffeine exposure during pregnancy might have less of an effect on primate brains.

Much more work needs to be done before scientists understand caffeine’s full effects on the rodent brain, much less a human brain, Silva says. “The purpose of our paper is not to make an alarm or say in a simple way that pregnant women cannot drink coffee.” ■

Blood marker may predict suicide

Activity of gene could help doctors assess risk

By Laura Sanders

A substance that has been found at elevated levels in the blood of people likely to kill themselves could lead to a simple test for suicide risk, researchers report August 20 in *Molecular Psychiatry*.

Right now, clinicians rely on people’s reported symptoms and feelings, but a person intent on suicide isn’t always forthcoming. A blood test would indicate to clinicians who is in immediate danger.

“There is such a need for markers,” says study coauthor Alexander Niculescu of Indiana University School of Medicine. “We need to advance this research very fast.”

The findings are “amazingly strong for a small sample size,” says psychiatrist J. John Mann of Columbia University and the New York State Psychiatric Institute.

The results came out of a larger study of 75 men with bipolar disorder. Subjects visited a clinic every few months, where they would undergo psychological testing and give a blood sample. During the study, nine men began with no signs of suicidal tendencies and later exhibited many.

Several biological molecules in the blood of these people also changed. Most notable was a molecule made by the gene *SATI*, which is involved in cell death. For these nine men, *SATI* activity tracked with suicidal thoughts and feelings.

To see if *SATI* activity might track with suicide more generally, the team obtained blood samples from a coroner’s office. Nine of nine men who had killed themselves had evidence of high *SATI* activity in their blood.

SATI activity was also tied to hospitalizations for suicidal behavior, the team found with another group of bipolar men. Researchers don’t know why *SATI* activity correlates with suicide risk.

“There are a lot of technical issues with this study,” cautions neuroscientist Carl Ernst of McGill University in Montreal. “There’s not a lot we can take from it at this stage.” The study followed a small number of men who were on various medications, he says. What’s more, it’s unclear whether men with bipolar disorder are a good proxy for suicidal people in general. ■

“There is such a need for markers. We need to advance this research very fast.” —ALEXANDER NICULESCU

Early life influences race perception

Time in homogeneous orphanage changed response to faces

By Laura Sanders

Seeing people from different races early in life may sculpt the developing brain, a new study suggests. Children who spent infancy in Chinese or Russian orphanages with little contact from outsiders had difficulty perceiving emotions on faces of people of different races. These children also showed heightened brain responses to faces of other races.

“Early exposure to faces of different races is important,” says psychologist Kang Lee of the University of Toronto. “The lack of such exposure can have long-lasting effects.”

The study, published in the August 14 *Journal of Neuroscience*, can't show what such effects might mean, says study

coauthor Eva Telzer of the University of Illinois at Urbana-Champaign. “Our findings do not say anything about children's behavior in their daily life.”

Telzer and her colleagues studied orphans who the researchers believe had lived amid a single race of people early in life. Most of the 36 children spent time in Russian or Chinese orphanages and were later adopted by American families of European descent. On average, the kids were adopted when they were 2 to 3 years old and were between 6 and 16 years old at the time of the study.

The children looked at a computer screen with a face showing a happy or angry expression. The kids then had to find that expression on one of two new faces. Overall, the orphans performed

just as well as 13 kids from Los Angeles, who presumably had grown up seeing lots of people of other races. But the adopted kids were worse at matching emotions on faces of unfamiliar races.

Among the adopted kids, brain scans revealed a heightened level of activity in the amygdala, a brain region sensitive to surprising events and threats.

Telzer thinks the racial environment had tuned the children's developing brains. Exposure to one racial group early in life primes the brain to become expert at recognizing faces of that group. This expertise may leave the brain worse at handling faces of other races.

But a hard orphanage life, and not necessarily a lack of racial diversity, could have influenced the results, says neuroscientist Charles Nelson of Harvard Medical School. And the scientists don't know for sure the racial makeup of the orphans' early environments. ■

Sugar gains power from mind

Attitudes about willpower changed glucose's effect

By Jessica Shugart

People who need sugary snacks to stay sharp could be prisoners of their own beliefs. The brain works just fine without regular shots of sugar in people who believe their self-control is unlimited, a new study shows.

“There's a dominant theory in psychology that willpower is limited, and whenever you exert yourself to do a hard task or to resist a temptation, you deplete this limited resource,” says psychologist Carol Dweck of Stanford University.

Previous studies have shown that mental exertion diminishes blood glucose levels and that a person's willpower can be rejuvenated by ingesting a sugary drink.

In the new study, published August 19



Will a doughnut increase a person's mental acuity? It depends on his or her views on willpower, researchers say.

in the *Proceedings of the National Academy of Sciences*, Dweck and colleagues asked students about their attitudes on willpower and then gave them lemonade sweetened with either sugar or a sugar substitute. Ten minutes after downing the beverage, the students took tests of self-control and mental acuity.


The students who believed willpower is self-generated scored equally well whether their drinks contained sugar or

not. But the students who felt willpower was limited needed sugar to perform as well as the other group did.

This was true even when the researchers told the students that their drinks contained sugar when they did not (and vice versa).

In another experiment, the researchers tweaked students' views by suggesting that willpower was either depleted or renewed in the face of a challenge. Students who were led to believe willpower was in short supply needed sugar to perform well on the tests; the others did not.

Dweck thinks that sugar sends a signal of renewed energy to the brain, a cue that people with a limited view of willpower are keen to pick up on.

A person on a healthy diet has an ample glucose supply for mental tasks, says Andrew Lane, a sports psychologist at the University of Wolverhampton in England. “If we needed shots of glucose to focus, we would've been eaten by whatever was in front of us and died out long ago,” he says. 

Earth



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Dueling theories on dune fields

C-shaped sand mounds persist by colliding or calving

By Erin Wayman

No sand dune is an island. Interactions between crescent-shaped, or barchan, dunes stabilize the sand mounds and explain how vast swarms of them can persist over time, two new studies find. But the studies don't agree on what kind of interactions matter: One team argues that dunes colliding and breaking apart keeps fields from growing into giant sand piles, while the other claims that dunes calving off each other is the key.

Even if they disagree, “both papers are providing convincing evidence that the generation of small dunes in a field is a very important ingredient to explain the structure of barchan corridors,” says Eric Parteli of the University of Erlangen-Nuremberg in Germany.

Barchans arise in deserts where the ground is hard and flat and strong winds blow sand in one direction. Thousands of the dunes can occupy

a narrow strip. Fueled by wind, the dunes travel at different paces and can traverse up to 100 meters in a year.

Scientists have struggled to explain what maintains these assemblages. “It's unclear why barchan dunes exist at all,” says Pieter Vermeesch, a geologist at University College London. Tiny dunes should shrink and disappear while big ones should grow infinitely large.

Mathieu G nois of Paris Diderot University and colleagues say collisions prevent dunes from growing out of control. If two barchan dunes collide, they can merge into one crescent or they can split up into multiple smaller barchans. In computer simulations of crashing dunes, barchans arranged themselves into patterns found in nature — evidence that collisions control dune field behavior, the team concludes August 7 in *Geophysical Research Letters*.

Stacey Worman of Duke University and colleagues offer an alternative explanation August 12 in *Geology*. When a dune grows to about 100 meters long, it amasses enough sand on its upwind side for an incipient dune to develop. Since small dunes migrate faster than large ones, the baby dune travels down one



Barchan dunes, like these in Skeleton Coast, Namibia, should grow out of control. Either calving or collisions could limit dune size, two studies say.

of its parent's horns and buds off. The team simulated calving dunes and also re-created real-world barchan patterns. The simulations included some types of collisions, but they didn't help stabilize dune size, says coauthor Brad Murray, a geomorphologist at Duke.

Scientists have observed both collisions and calving in barchan fields. It's possible that one process plays a more important role than the other in shaping dune swarms, says geomorphologist Christopher Hugenholtz of the University of Calgary in Canada. The only way to confirm that is with satellite images collected repeatedly over several years to see how dunes evolve. ■



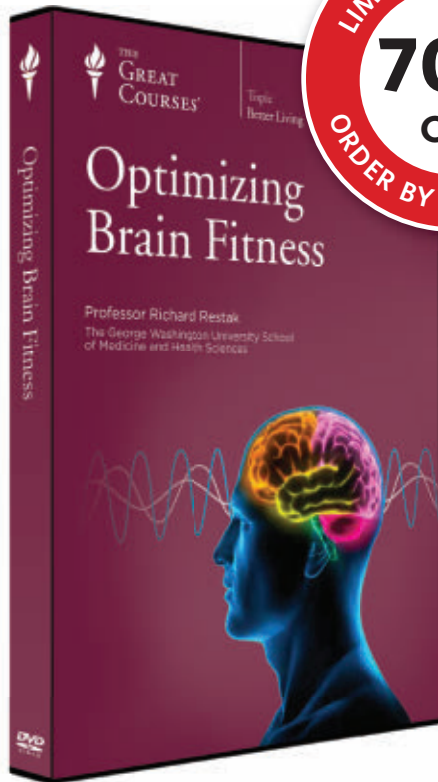
Fast magma flows fuel eruptions

Molten magma can cruise at high speeds from deep in the Earth to the surface, triggering volcanic eruptions. The discovery suggests that advance warning of an eruption might come from monitoring seismic action deeper in the crust than scientists usually look.

The new analysis, published in the Aug. 1 *Nature*, looked at the distribution of minerals and elements in ash from the 1963–65 eruption of Costa Rica's Iraz  volcano (shown). When scientists Philipp Ruprecht and Terry Plank of Columbia University's Lamont-Doherty Earth Observatory examined tiny crystals of the mineral olivine, they saw much more nickel than expected. That suggests that some of the volcano's magma hadn't been stewing near the surface, but instead came fresh from Earth's mantle.

The researchers calculated that magma may flow up from the mantle at speeds of 80 meters per day, creating what they call a “highway from hell.” This activity probably fueled the eruption. If the same sort of plumbing connects the mantle to the crust at other volcanoes, then keeping an eye on deep crust activity could provide clues to eruptions. — Rachel Ehrenberg

FROM TOP: MICHAEL POLIZA/NATIONAL GEOGRAPHIC CREATIVE; P. RUPRECHT



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Details of migration into the Americas revealed in DNA

Analysis of genetic material from modern people shows three distinct waves of arrival

By Tina Hesman Saey

The early inhabitants of the Americas entered the New World in three stages and by three distinct routes, a new genetic analysis of living Native Americans suggests.

About 15,000 to 18,000 years ago, the first migrant wave spilled from Asia down the Pacific coast and then pushed inland, eventually peopling the land from “the tip of South America all the way to Hudson Bay,” says Andrew Kitchen, a genetic anthropologist at the University of Iowa who was not involved in the new research. That first migrant wave contained the ancestors of all South and Central American tribes, and North Americans, too. Later migrations changed the genetic mix of North Americans, a team of researchers has discovered.

The scientists examined the DNA of mitochondria, tiny power plants within cells that get passed down from mother to child. Scientists use mitochondrial DNA from living populations to decipher ancient movements of their ancestors. Most studies have examined only a small part of the mitochondria’s circular piece of DNA. Now, Antonio Torroni, a geneticist at the University of Pavia in Italy, and his coauthors have compiled complete mitochondrial genomes from 41 native North Americans and combined that data with information from previous studies.

The result is the clearest picture yet of the complicated movements of people into the Americas, says Theodore Schurr, a molecular anthropologist at the University of Pennsylvania.

The analysis, published August 12 in the *Proceedings of the National Academy of Sciences*, supports the widely accepted notion of an initial coastal migration wave. A second wave of migration

probably left Siberia only a couple thousand years after the first wave. Instead of trickling down the coast, the second group slipped through an ice-free corridor running from Alaska into what is now southern Canada, the team found. The second wave never made it south of the present-day United States.

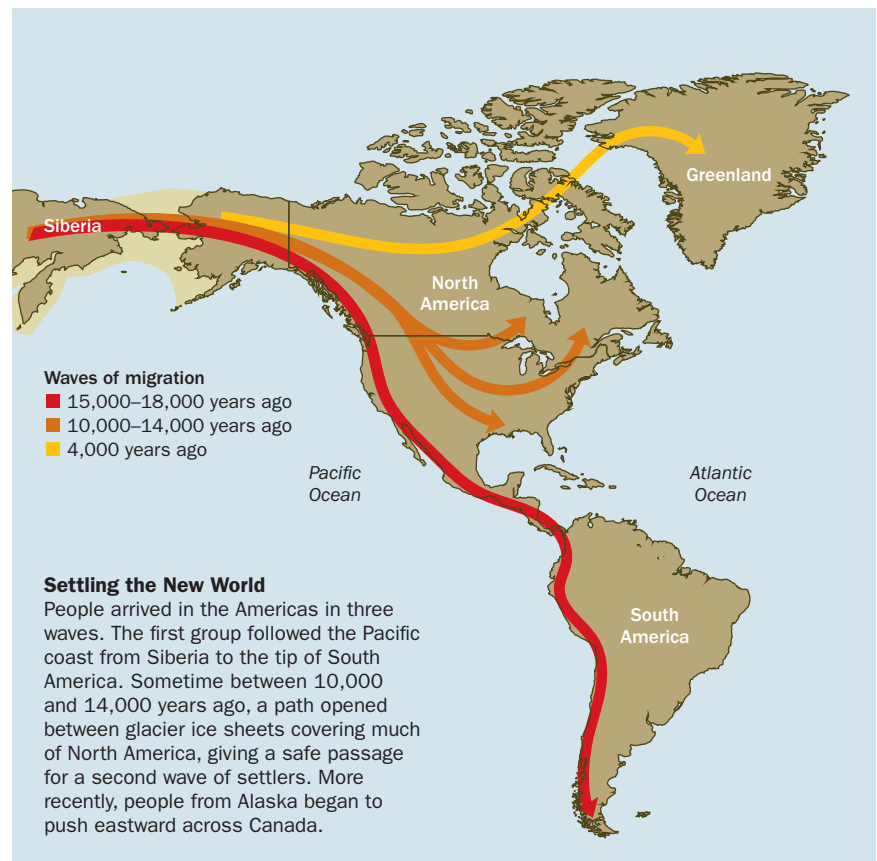
The mixture of first-wave and second-wave genetic signatures in some Native Americans today indicates that the newcomers and existing populations interbred.

A third wave of migration started around 4,000 years ago in Alaska and swept mostly eastward across Canada.

Some previous studies of human migration into the Americas have focused on two types of languages found in North America: the Na-Dene

language family, including Navajo, Apache and Tlingit, and non-Na-Dene languages, including Algonquin, Ojibwe and Chippewa. Scientists had thought the language groups reflected genetic separation, with the second wave being restricted to the Na-Dene language family. But Torroni and his colleagues discovered that second-wave genetic marks occurred in people who spoke languages from both groups. The finding suggests that the language families diverged after the people arrived, and gives a more dynamic picture of what was happening in eastern North America, says Kitchen.

The cultural change could even have happened within a generation, Torroni says: “Language mutates much faster than the DNA.” ■



“Clinicians frequently view borderline personality disorder symptoms as signs of badness, not sickness.” —SANDRA SULZER

‘Borderline’ is code for ‘difficult’

Many clinicians consider personality disorder untreatable

By Bruce Bower

Psychiatrists regularly get criticized for turning typical life problems into medical disorders. But in an odd reversal, many mental health clinicians are trying to transform one certified mental illness, borderline personality disorder, into a label for needy, manipulative people who don’t need treatment, a sociologist reported August 11.

Patients with borderline personality disorder, unlike people with schizophrenia or other serious mental conditions, are often viewed by mental health providers as having cynically planned out rash acts and even suicide attempts, sociologist Sandra Sulzer of the University of North Carolina at Chapel Hill found in extensive interviews with 22 psychiatrists and psychologists in the United States.

The condition includes difficulty controlling emotions, intense but unstable relationships, recklessness, cutting and other acts of self-harm, along with attempted and completed suicides. Before Sulzer’s study, little was known about how mental health professionals discuss and deal with this troubling set of symptoms.

“Clinicians frequently view borderline personality disorder symptoms as signs of badness, not sickness, and as a code to route patients out of mental health care,” Sulzer said. That finding goes a long way toward explaining why many people with borderline personality disorder receive no treatment despite the availability of effective forms of psychotherapy (*SN: 6/16/07, p. 374*), she suggested.

Sulzer carried out her interviews of mental health workers shortly before

the release of the latest manual of psychiatric disorders, the *Diagnostic and Statistical Manual of Mental Disorders*, or *DSM-5* (*SN: 6/29/13, p. 5*). Before its release, proposed revisions that would tighten up the definition of borderline personality disorder created controversy among psychiatrists and members of the committee writing the revisions.

Sulzer doesn’t know whether inadequate training or other factors explain why only a couple of clinicians regarded borderline personality disorder patients as having a treatable mental condition.

Borderline personality disorder patients can indeed be frustrating to treat, remarked Jerome Wakefield, a social worker at New York University who has criticized *DSM* for incorporating normal forms of sadness into the definition of depression.

Still, Sulzer’s findings show that the boundary between frontline clinicians’ definitions of bad and mentally disordered behavior demand much closer scrutiny, Wakefield said. ■

MEETING NOTES

Facebook doesn’t feel right

A big chunk of social media users say that digital communication doesn’t hold an old-fashioned candle to talking face-to-face. Among 300 tech-savvy college students, roughly half feel uncomfortable interacting on Facebook, Twitter and other social media but do so because it’s unavoidable, Zeynep Tufekci of the University of North Carolina at Chapel Hill reported August 10. Tufekci and Matthew Brashears of Cornell University developed a questionnaire to measure a person’s inability or unwillingness to relate to others via social media. Tufekci calls this disposition cyberasociality. Students who are cyberasocial are not especially extraverted or introverted, Tufekci said.

—Bruce Bower

A bar to marriage for the poor

Middle class values’ spread among poor black people may help perpetuate single parenthood. Unmarried black parents frequently say they want to get married, but first need to get a decent job and save enough money to buy the proverbial house with a white picket fence, Sara McLanahan of Princeton University reported August 12. That often unattainable standard makes it hard for partners to commit to a relationship, McLanahan found. Breakups are common, followed by both partners having additional children in new relationships. McLanahan directed a project that regularly interviewed unmarried parents of about 25,000 first-born children in 20 cities, from the child’s birth to age 9. She and her colleagues have also closely monitored 75 unmarried parents for four years. —Bruce Bower

The romance of cybercruelty

High school dating can be harsh, especially on the Internet. Teens launch malicious digital attacks most often against past boyfriends or girlfriends and former buddies, Diane Felmlee of Penn State University in University Park reported August 11. In the realm of computerized nastiness, social outcasts in high school largely escape the fray, Felmlee said. Gay students, however, draw more than their share of cyberattacks, including posts that mock them for not being heterosexual. Felmlee and Robert Faris of the University of California, Davis, interviewed 788 students at a Long Island private high school during the spring of 2011. About 20 percent of the students instigated cyberstrikes or were victims of such attacks.

—Bruce Bower

News in Brief



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MIND & BRAIN

Personal space has a boundary

People have sharp no-fly zones around their faces. Though the boundaries depend on the person, this discomfort area usually starts between 20 and 40 centimeters away and continues right up to the face, researchers report August 28 in the *Journal of Neuroscience*. Threatening objects that enter this forbidden space are likely to trigger a strong defensive reaction. Scientists knew that this safety margin exists, but its boundaries hadn't been measured. Chiara Sambo and Giandomenico Iannetti of University College London zapped 15 people on the wrist, a process known to make people blink defensively. Simultaneously, the researchers moved the same hand closer and closer to the subjects' faces and measured the amount of blinking that ensued. On average, people displayed a boundary between about 20 and 40 centimeters before rapid blinking signaled a defensive reaction, the experiment showed. What's more, personality changed the size of the zone: People who reported more anxiety needed a wider berth.

—*Laura Sanders*

EARTH

Predicting risk of arsenic exposure

Nearly 20 million people in China may be exposed to drinking water contaminated with arsenic, suggests a new simulation that uses environmental factors to calculate the risk of exposure in a particular area. Globally, about 140 million people drink groundwater with unsafe levels of arsenic, which can cause cancer and other health problems. Testing individual wells for the poison is time consuming, so a team including Luis Rodríguez-Lado, now at the University of Santiago de Compostela in Spain, developed a faster way to assess an area's arsenic risk. The researchers identified eight environmental variables that can predict whether a region's groundwater has high arsenic concentrations.

For example, arsenic contamination tends to happen in wet areas with salty soil and sediments younger than about 12,000 years, the researchers report in the Aug. 23 *Science*. After using these and other factors to map the arsenic risk in China, the researchers matched risk with population data to estimate that roughly 19.6 million Chinese people live near contaminated groundwater. The same technique could be used to predict arsenic risk in other countries.

—*Erin Wayman*

GENES & CELLS

Bats can carry MERS

The virus that causes a deadly new respiratory disease known as Middle East respiratory syndrome, or MERS, has been found in a bat in Saudi Arabia. The finding suggests that animals may transfer the virus to humans. The disease was first diagnosed in a Saudi Arabian man last September (*SN*: 3/23/13, p. 5). Since then, 104 people have gotten sick from the virus and 49 of them died. Scientists haven't figured out how the virus got into humans. Recently, the Saudi Arabian Ministry of Health worked with researchers from Columbia University and the EcoHealth Alliance in New York City to catch bats that live near the home and business of the first person diagnosed. The feces from an Egyptian tomb bat, *Taphozous perforatus*, contained a virus that perfectly matched the MERS virus that killed the first patient, the researchers report in the November *Emerging Infectious Diseases*. Camels had been implicated in spreading MERS to humans, but no actual evidence of the virus was found in the animals.

—*Tina Hesman Saey*

ENVIRONMENT

Carbon storage at max for Euro trees

Europe's forests are nearing their capacity to stockpile carbon, researchers warn August 18 in *Nature Climate Change*. Full forests mean more carbon

dioxide—a greenhouse gas—in the atmosphere. Centuries of deforestation shrunk Europe's forests, but since the 1950s the continent's woods have been steadily recovering. For more than 60 years, the forests have been major carbon caches, or sinks: A hectare of mature forest can hold 65 metric tons of carbon. Gert-Jan Nabuurs of Wageningen University in the Netherlands and colleagues analyzed data from 29 European countries and found early warning signs that forests' room for storage has nearly topped out. The aging trees aren't growing as fast as they once did, and they're more susceptible to fires and insects, the researchers report. Urban sprawl is also curbing the spread of forested areas. European countries should consider changing forest management strategies to make the carbon sinks last, the authors suggest.

—*Meghan Rosen*

ATOM & COSMOS

NASA gives up on fixing Kepler

NASA's planet-hunting Kepler space telescope, hobbled by the breakdown of two crucial parts, is beyond repair, officials announced August 15. In May the Kepler team reported that two of the four reaction wheels used to turn the spacecraft toward its stellar targets had failed, leaving the telescope incapable of detecting the small dips in starlight that signify the existence of distant planets (*SN*: 6/15/13, p. 10). Last month engineers tried using one troubled wheel, plus the two functional ones to direct the scope. Kepler worked for about six hours before the wheel encountered so much friction that the telescope automatically turned itself off. Resistance to spin is a death sentence for telescopes that rely on reaction wheels. Kepler scientists are now exploring what the telescope can accomplish with just two reaction wheels. In the fall NASA will determine whether that justifies any of the roughly \$18 million allocated to the mission this year. —*Andrew Grant*

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COLLISION COURSE

Scientists struggle to make windows safer for birds

By Susan Milius

Ornithologist Christine Sheppard, frowning as if she's lost something, squints into the darkness of a 30-foot-long contraption. It looks like a stretch-limo version of a garden shed, but one end sports high-tech glass available only from an industrial R&D lab. From a hole at the other end dangles a child's pajama leg.

What Sheppard has lost is a song sparrow. She is using the tunnel contraption to test whether birds will fly into the piece of glass at the end. Since birds often don't see glass and fly right into it, Sheppard hopes to test whether stripes or other markings on the glass can warn birds away from a fatal impact. The pajama leg provides a soft chute to slip a sparrow or other bird into at the dark end of the tunnel. The bird flies toward the light-filled windows at the other end, and at the last instant a hair-fine net in front of the glass prevents a collision.

This setup, at Powdermill Avian Research Center in Rector, Pa., is one of three in the United States testing ways to prevent birds from flying into glass. According to one oft-quoted estimate, window crashes account for up to a billion bird deaths a year in the United States alone.

Creating no-crash glass has turned out to be much trickier than it sounds. The researcher behind the first U.S. glass-testing setup for birds, ornithologist

Daniel Klem Jr., has been working on the issue for about four decades. His is a tale of the perils of applied science, from “aha” moments to entrenched public resistance and commercial disinterest. Basic research on bird vision has flourished, shedding light on what birds can and can’t see, but translating neuroscience into safer window designs and getting them adopted is not so easy.

Ironically, the green building movement of recent years has made landscapes even more dangerous, Sheppard says. Efforts to shave energy costs by letting in more natural light have meant more glass for birds to collide with. But now she’s working with architects and glass companies in ways that may at last hatch a market for bird-safe products. Tests show that opaque stripes or dots on windows can reduce bird kills, if people are only willing to use them.

But both Sheppard and Klem have been searching for the Holy Grail of bird safety: windows with patterns that birds can see but that are invisible to people. It is not an exact science. So far this morning at Sheppard’s tunnel, one test subject darted out an uncapped observation hole instead of completing the test flight. A crow just walked down the tunnel. The lost song sparrow has caused a temporary halt in tunnel operations. The bird is free to fly through the open door, but it’s lingering inside in the cozy darkness. Sheppard grabs a long-handled net and is preparing to clamber into the tunnel herself when — whoop! — the sparrow flies.

Population unknown

It’s hard to find a good number for just how many birds die in window collisions. Klem is the source of the numbers stating that U.S. windows kill 100 million to 1 billion birds a year. “I blatantly and openly tell you they’re estimates,” he says.

Klem’s numbers are based on his 1990 estimates of the number of birds a typical building kills annually (between one and 10) and the number of buildings in the United States (based on 1986 data). Now Scott Loss of Oklahoma State University in Stillwater and colleagues are creating a new estimate using data on per-building mortality rates from 23 studies.

Whatever the new estimate is, there will be debate over what it means for total bird populations. Many species of North American birds are declining in numbers, but they also face degraded habitat, pollutants, invasive species, wind turbines and other hazards. The scale of the hazard windows pose won’t be clear without comparable studies of local populations, Loss and colleagues argued in 2012 in *Frontiers in Ecology and the Environment*.

For ornithologists and bird lovers, though, buildings that kill wildlife are disturbing regardless of total population impact. Architect Anne Lewis leads City Wildlife project volunteers who get up before dawn to walk through downtown Washington, D.C., documenting birds that have crashed against glass. Sometimes she picks up stunned birds, placing them in paper bags to rest before being released in leafy parks far from dangerous glass. “Sometimes they die in your hand,” she says. “It makes a believer out of you.”

Bird safety basics

Witnessing bird collisions made a believer out of Daniel Klem while he was still a graduate student. One day in 1974, he sat down on a bench in front of the mirrored-glass chemistry building at Southern Illinois University Carbondale. “It only took about 20 minutes,” he remembers. A mourning dove thumped

against an upper story of the building so hard that feathers scattered, and the bird dropped to die on the ground.

At the time, no one knew why birds fly into glass. A 1931 scientific report on yellow-billed cuckoo crashes treated the deceased as “rare, self-destroying incompetents,” says Klem, now at Muhlenberg College in Allentown, Pa. As the building boom after World War II fed demand for picture windows and glass walls, accounts of birds crashing into windows surged. So

did speculations on the cause. Perhaps the birds just didn’t understand glass. Or their eyes were bad. Or sun glare, mist or smoke temporarily blinded them. One report even suggested the birds were drunk on fermented fruit.

Klem began to set up experiments. He propped panes of clear and mirrored glass against tree trunks at the edge of the woods on his adviser’s property, and he built a 12-foot Masonite tunnel, the first ever for testing windows. Birds flew toward a pane of clear glass as readily as through an empty window frame, showing no sign they could tell glass from air.

“It’s the glass, stupid,” is Klem’s sloganized conclusion. Birds just don’t see clear glass as an obstacle. Reflections may even lure them toward what appear to be trees, grass or other shelter that actually lie behind them.

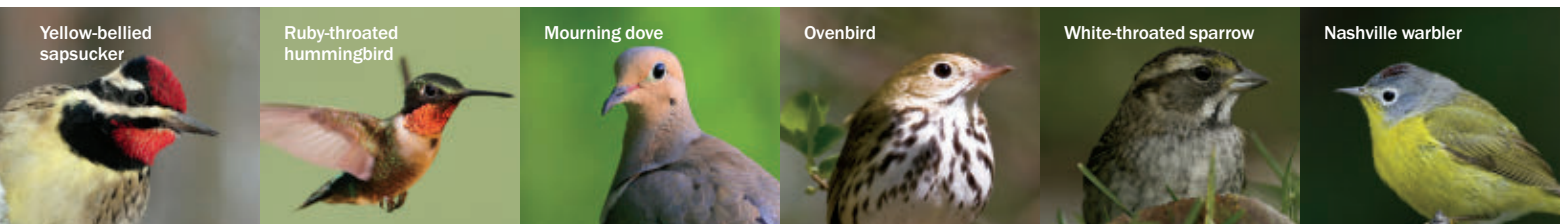
To see how people might warn birds away from glass, Klem began testing bird-deterrence markings in his tunnel. He compared a plain pane with glass adorned with something: stripes, silhouettes of predators or even blinking lights.

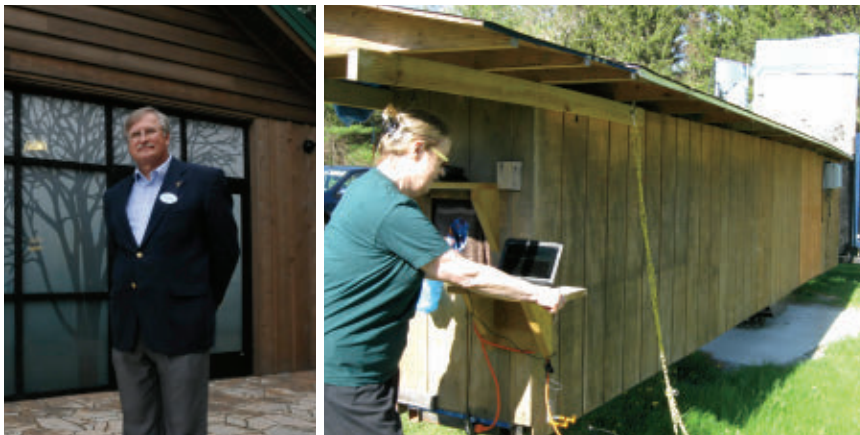
Below are a few U.S. bird species often found dead after flying into glass, according to surveys by wildlife groups in Washington, D.C., and Chicago.

100 million to 1 billion

Estimated number of birds killed by glass collisions annually in the United States

FROM LEFT: STEVENRUSSELL SMITH/PHOTOS/SHUTTERSTOCK; STEVE BYLAND/SHUTTERSTOCK; STEVE BRIGMAN/SHUTTERSTOCK; WILLIAMSHERMAN/ISTOCKPHOTO; PAULREEVES/PHOTOGRAPHY/SHUTTERSTOCK; GERALD MARELLA/SHUTTERSTOCK





Daniel Klem (left) has been trying for decades to convince people to use simple bird-safe methods like the decoratively coated glass behind him. Christine Sheppard (right) tests birds' reactions to new kinds of glass in her testing tunnel.

(A lone predator decal is useless.)

His results helped establish what's now known as the two-by-four rule. Most birds won't fly through a space less than 4 inches wide between vertical stripes or 2 inches high between horizontal stripes.

This finding has had conspicuously little impact on offices, homes, airports, bus shelters and the rest of the increasingly glassy world. The failure has little to do with the birds or the experiments. "People told me time and time again, 'You know, Dan, you go mucking around with the way people look through their windows, and you're going to lose,'" he says. Any pattern obscuring a view means counterintuitive marketing for anything but bathrooms.

Then came a *Nature* paper in 1978 from prominent ecologist Thomas Eisner of Cornell and a colleague reporting evidence that homing pigeons react to real-world ultraviolet light. "From the very instant I read about it, I was excited," Klem says. "I was beside myself, thinking this could be the Holy Grail."

People can't see the very short wave-

lengths, from 100 to 400 nanometers, that make up ultraviolet light, but it turns out that pigeons and many more birds can. In theory, window patterns that show up only in UV could warn birds of a no-fly zone while giving humans a clear view.

But after the initial thrill, Klem says, "I realized there wasn't any way for me to test this." He contacted glass companies, people who might know product developers, people who might know people, searching for a material that reflects UV wavelengths but not others. He found a lot of UV absorbers, but no useful UV-only reflectors. He refers to this period as a "time when I was in this frustration — which was most of the '80s and the '90s."

Eventually a chemist who developed window films for cars happened to hear a radio interview with Klem, and as a side project devised a UV film that reduced bird crashes. The chemist's company deemed the project financially untenable, though, and yet another attempt to finance it has fallen through within the last year. A few other companies are now

testing and even marketing UV-reflecting products such as decals and glass.

As for testing the effectiveness of such products, Klem argues that tunnels are "informative but not completely reliable," because they are not very accurate mimics of windows in actual buildings. Instead, he mounts glass to be tested and clear glass for comparison in frames, shuffling positioning to counteract quirks of lighting or location. He scores effectiveness by comparing numbers of carcasses or smudges on each pane. He omits nets, he says, because they can be visible from some angles and in some lighting, distorting results.

He's far from the only scientist to sacrifice animals in a study. "It's a part of the work that I grimace at," he says. He tells his students that when extraterrestrial scientists finally reach Earth, it's only fair that he volunteer as their specimen. But unless he can trust that his results are realistic, he says, he runs the risk of "sanctioning something that is continuing to kill animals."

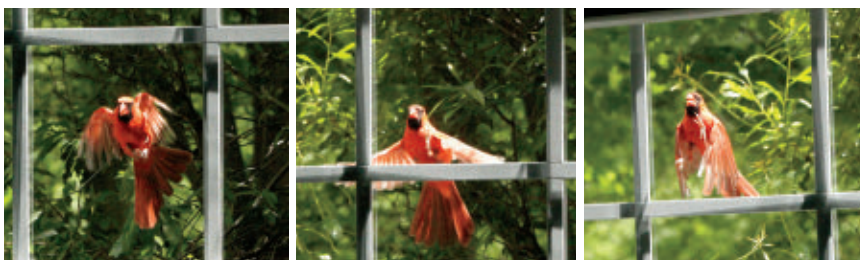
For decades, mainstream ornithology wasn't exactly ignited by Klem's interest in window glass, and a 2003 magazine profile called him "the Rodney Dangerfield of ornithology." As far as a widespread awareness of collision hazards that fuels a broad resolve to change windows, "we're still quibbling," he says. "I'm an educational failure."

Bird's-eye view

While Klem struggled with window treatments, basic research on avian vision flourished, with ever more precise analyses of eye structure, nerve responses and which genes turn on when. These scientists haven't been talking to people like Klem who work on practical problems, says Graham Martin of the University of Birmingham in England.

And if they were to talk, it's not clear what they could say except that

Reflections not only cause collisions but also affect behavior. This cardinal crashed repeatedly, though not fatally, into a window, defending its territory from a reflection.



CLOCKWISE FROM TOP LEFT: BILL UHRICH/HAWK MOUNTAIN; S. WILLIUS; JOHN SCHERR

designing a UV pattern to warn a bird about glass could be difficult.

For one thing, most birds' eyes are on the sides of their heads. "Birds have got this fantastically comprehensive visual field," Martin says, "but the best vision for most birds is actually out sideways."

In some big birds, such as eagles, bustards and the two vulture species Martin reported on in *Ibis* in 2012, a gap between the left and right visual fields creates a blind spot to the upper front. "As soon as they start to look down, they're effectively flying blind," Martin says.

This gap means these birds may not see an obstacle ahead, nor would they see warning patterns ahead. "They're flying with the assumption — that has been a pretty good one for the last God knows how many millions of years — that there won't be anything sticking up in the way," Martin says.

Songbirds, which are more often killed by windows than are the big scavengers and birds of prey that Martin studies, do not have this big frontal blind spot. But even for them, "forward vision is not so good," Martin says. Birds, like people, typically get their sharpest view in the center of the eye's field of view. For side-eyed birds, that's to the side. Martin predicts that patterns to the front probably need to be extra bold for birds to notice them.

Another problem in creating bird-visible patterns is that birds are not as sensitive to contrast as people are. For a typical bird to pick out a grayscale pattern, the contrast between grays has to be about 10 times greater than it would for a human observer, says Almut Kelber

of Lund University in Sweden.

There are other problems specific to developing UV-reflecting patterns. Even one of the commonly repeated examples of birds seeing UV signals in nature may not be true, Kelber and her colleagues argued in May in the *Journal of Experimental Biology*. A 1995 paper had proposed that birds of prey track voles in Finland by catching the UV glimmer of their urine dribbled across the landscape. Kelber found that lenses and fluids in the eyes of kestrels filter out much of the UV. And in any case, the voles Kelber's team tested didn't

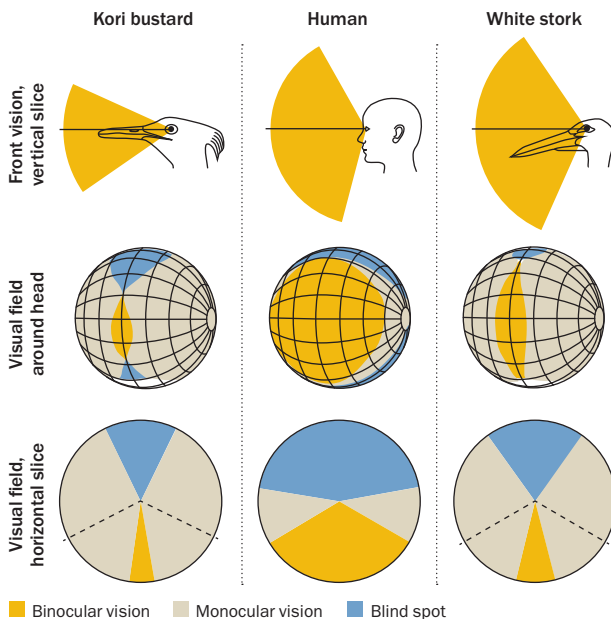
pee in ultraviolet. This doesn't mean that other birds have trouble seeing in UV. But Kelber cautions against generalizing about bird vision based on the small number of species that have been tested.

What's more, perceiving ultraviolet patterns while in motion "might be impossible for birds," says Daniel Osorio, a color vision expert at the University of Sussex in England. The part of the bird's midbrain that analyzes motion receives

information from cells in the eye that aren't sensitive to ultraviolet, current evidence suggests.

Neither Osorio nor Martin is optimistic about UV-reflecting patterns after attending a symposium on birds and glass at a September meeting of European ornithologists. Birds may not be sensitive enough to UV to detect a warning pattern on an actual window, researchers suggested at the meeting.

Visual fields of birds and humans



Where birds see With eyes on the sides of their heads, birds have a different field of view than humans. Africa's Kori bustards have a narrower vertical range of binocular vision than people or storks. If a bustard looks 25 degrees down, it has a blind spot to its front. The middle row shows areas of each vision type surrounding each animal's head, facing the center of the yellow binocular zone. The bottom row shows a slice through the equator of those spheres, showing humans' large rear blind spot compared with birds.

Bird-safe by law

In some places, regulations are beginning to encourage or require more bird-safe architecture. Minnesota mandates that buildings that receive state funds include certain bird-safety features in plans for environmental friendliness. Since 2011, buildings in San Francisco's bird-rich areas near parks or water must meet avian safety requirements, and Oakland, Calif., this year added a layer to its building permit process requiring feasible improvements in protective measures for birds.

Toronto has been a center of activity for bird-safe

buildings, with pioneering regulations, and this year an unusual lawsuit. A major property company, Cadillac Fairview, ended up in court because the massive glass facades on its Yonge Corporate Centre were killing birds.

The company was acquitted this year after, the decision noted, installing window-taming treatments that cost about \$100,000. The judge stated that emissions of reflected light from windows causing bird crashes should be considered violations of Canada's environmental laws.

—Susan Milius



Bird-safe can be beautiful, advocates say. Chicago's Aqua Tower (left) has textured (or fritted) glass and balconies limiting birds' view of windows. Other strategies include UV-reflecting patterns (Ornilux glass, top right) and window shades (bottom right).

Build it

Experiments on birds won't do any good if there's no market for the results, though. So Sheppard is taking her case to architects and glass manufacturers. Her testing tunnel results are now what some companies rely upon to rate the safety of new kinds of glass for birds.

For the first two decades of Sheppard's ornithology career, she didn't bother with experiments since she had an obviously successful device: soap.

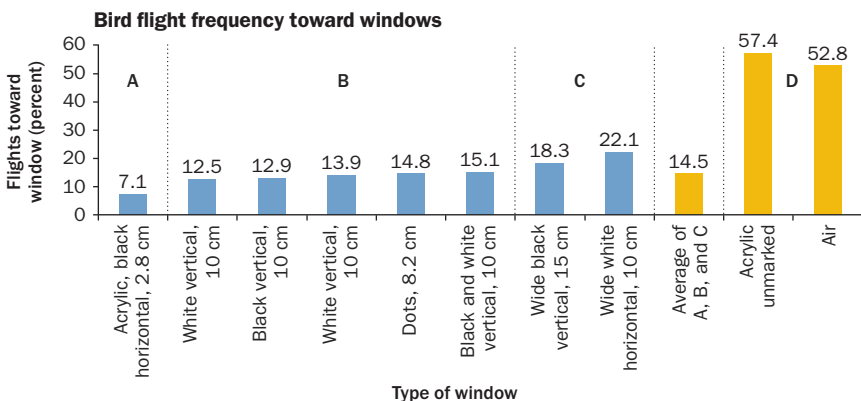
When she finished her Ph.D. and went to work for the Wildlife Conservation

Society's Bronx Zoo, the staff routinely smeared soap on any expanses of glass surrounding a new bird on exhibit. The newcomer would avoid the solid-looking windows. Once it learned its way around, the staff would wash off the soap.

Then the zoo planned to build a new Center for Global Conservation and turned to Sheppard for advice on keeping the building from becoming a bird killer. The moment she found an Internet reference to a nonlethal contraption in Austria for testing glass, she decided to build one.

She now has one testing tunnel at

Glass houses Researchers in Austria tested nearly 800 bird flights toward windows covered with stripes, dots or no marks (listed below with distance between markings). The results are grouped from most bird-safe (A) to least (C). Acrylic panes, or Plexiglas, containing thin black horizontal filaments were the top performer. In other tests (D), birds were at least as likely to fly toward unmarked acrylic as toward an empty window frame. SOURCE: M. RÖSSLER ET AL./BOKU VIENNA 2009



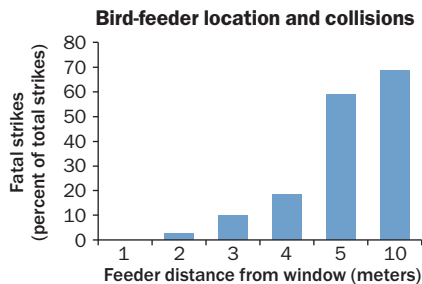
Pennsylvania's Powdermill Nature Reserve and a new one at the Bronx Zoo. She also has what may be the only job in the world devoted to making buildings safe for birds, at the American Bird Conservancy. She has made trade-offs in experimental design different from those in Klem's work. Sheppard's controlled flights in tunnels give results from a large number of test birds of known species, without harming any. But the birds fly from a dark tunnel toward a light-filled window, which isn't what usually happens in real life. "I'm not trying to be realistic," she says. "I'm testing patterns."

Opaque dots and stripes covering as little as 5 percent of glass surface can prevent 90 percent of collisions, she says (see sidebar, facing page). What architects dream about, though, are patterns invisible to humans, and those are harder to develop. Ornilux, made by Arnold Glas in Germany, carries subtle, irregular crisscross bands that reflect UV. This glass tested as bird-visible in Sheppard's Powdermill tunnel. For Klem, the protection worked only if there was less light behind the window than in front of it, he and a colleague report in the June *Wilson Journal of Ornithology*. Though Sheppard and Klem emphasize different elements of experimental design, both acknowledge that lighting and other conditions vary in real life. "Architects need to take our results, along with what we know about reflections, and make informed decisions," Sheppard says.

In another of Sheppard's tests, panes with tiny white dots on the glass surface didn't seem to alert birds to an obstacle. Birds were almost as likely to veer toward a panel as away from it. Increasing the density of the dots — which made more of the glass opaque — helped. It looked like a simple case of covering more surface area.

But then Sheppard tested glass panes

CLOCKWISE FROM TOP LEFT: CHICAGOGEEX/FLOCKR; ECOMBETZ/WIKIMEDIA COMMONS; SAJI SASAKI/FLOCKR



Feeding bird deaths Bird feeders can draw birds toward windows, but are less deadly if placed within a meter of glass. Birds may be drawn to the feeder instead of windows and are not flying as fast if they hit a window while flying away. SOURCE: D. KLEM ET AL./WILSON BULLETIN 2004

with eighth-inch-wide lines instead of dots. Glass marked with either vertical or horizontal lines scored much better than the dotted panels — even though the lines covered about the same small fraction of the surface. “It became very clear it’s not simply the coverage,” Sheppard says. Within certain limits, stripes appear to be more effective for their size than dots as practical warning signs on buildings.

To get any of these solutions in place, “you have to get to the architects,” Sheppard says. She helped the Green Building Council develop a way to calculate a building’s lethality to birds. In 2011 they began a pilot program to add a collision-deterrence credit to the LEED program, or Leadership in Energy & Environmental Design, which certifies buildings as environmentally responsible. To get the credit, architects have to minimize clear panes, and their see-through acreage can expand in proportion to how well the glass performs in Sheppard’s tunnel test.

One spring day at the Powdermill bird-banding station, a pane with a UV pattern (Sheppard can’t say more about the proprietary material) sits in the testing slot beside regular glass. At this time of year, the bird-banding crew starts at 5 a.m. six days a week, trooping through shrubbery every half hour to check the nets that capture birds to be banded and tested. Birds hang in dark clots of tangled threads. In dozens of quick miracles, banders unsnarl them and fit each bird into its own beige cloth bag. To keep their hands free, the banders

Bird safety dos and don’ts

Even small panes of glass can trick a bird into a fatal crash, and some products sold for bird safety may not work, warns Christine Sheppard of the American Bird Conservancy. Here are some solutions that Sheppard recommends:

Recommended

- **Window screens** reduce bird collisions by reducing reflections and providing a softer surface.
- **Washable tempura paints** can provide a simple warning and can be changed seasonally as decoration.
- **Shutters or exterior shades** can be closed when no one is looking out a window or during high-risk seasons for collisions, such as spring and fall migration.
- **Stripes or dots on the outside of glass** can break up reflections. Ideally, vertical lines should be spaced no more than 4 inches apart, horizontal lines no more than 2 inches apart.
- **Fritted glass**, which has a rough surface, reduces reflections and collisions as long as the fritting is on the outside surface.

Not recommended or problematic

- **A single predator decal** such as a hawk silhouette is not recognizable to birds as a dangerous predator. Arranging multiple decals could deter birds by reducing a window’s transparent area, but decal shape does not matter.
- **Light-colored blinds or shades** inside windows may be better than nothing, but depending on the lighting, birds can still see deceptive reflections.
- **Overhangs or awnings** can block a window from sight for birds above but can leave birds with views of reflected plants and sky.
- **Glass slanted** at least 20 degrees from the vertical reduced deaths in tests near feeders, but Sheppard says this may work only when birds fly parallel to the ground.

clip each bag to a cord around their necks, creating broad necklaces that occasionally twitch.

Thus dressed, the crew strides back to a snug room. Hands slide into anonymous beige bags and emerge with delicate creatures, the technicians working with the intensity of a surgical team to measure birds as quickly as possible.

Sheppard and technician Matthew Webb, hovering on the edges of the controlled rush, accept a bag and step across the station’s yard to the glass-testing tunnel. Webb pulls out a yellow warbler, brilliant as a daffodil and only somewhat bigger. Webb squints at the numbers on its leg band, reads them into the video recorder and slips his handful of bird into the tunnel. Seen from outside, there’s just a man with one arm down a pajama leg.

The actual test is so fast, just two or three seconds, that it’s almost anticlimactic. Webb, watching the small screen of the video recorder aimed into the tunnel,

suddenly pronounces “indirect right,” and it’s over. The warbler has swerved and ended up on the right, flying away from the UV-treated glass. Sheppard opens a large door, and in seconds a yellow dot of warbler blurs off toward the shrubs.

Across the yard, windows in the banding station carry fleets of translucent tape, with admirable two-by-four spacing. They shouldn’t be a menace to the warblers, sparrows, kinglets, wrens, flycatchers and literally hundreds of other travelers darting through the woods. But after starting to think about glass, it’s hard to stop. Just down the road in the town of Donegal, more windows loom in the houses, the Dairy Queen, the turnpike tollbooths. So many windows, and still so few stripes. ■

Explore more:

- See the American Bird Conservancy’s report, “Bird-friendly building design,” at bit.ly/SNbirdsglass



THE TUNE WRECKERS

Lousy singers make a pitch for scientific relevance **By Bruce Bower**

Strange things happen when bad singers perform in public.

Comedienne Roseanne Barr was widely vilified in 1990 after she screeched the national anthem at a major league baseball game. College student William Hung earned worldwide fame and a recording contract in 2004 with a tuneless version of Ricky Martin's hit song "She Bangs" on *American Idol*. Several singers at karaoke bars in the Philippines have been shot to death by offended spectators for mangling the melody of Frank Sinatra's "My Way."

For all the passion evoked by pitch-impaired vocalists, surprisingly little is known about why some people are cringe-worthy crooners. But now a rapidly growing field of research is beginning to untangle the mechanics of off-key singing. The new results may improve scientists' understanding of how musical abilities develop and help

create a toolbox of teaching strategies for aspiring vocalists. Glimpses are also emerging into what counts as "in tune" to the mind's ear. It seems that listeners are more likely to label stray notes as in tune when those notes are sung as opposed to played on a violin.

Running through this new wave of investigations is a basic theme: There is one way to carry a tune and many ways to fumble it.

"It's kind of amazing that any of us can vocally control pitch enough to sing well," says psychologist Peter Pfordresher of the University at Buffalo, New York.

Still, only about 10 percent of adults sing poorly, several reports suggest (although some researchers regard that figure as an underestimate). Some of those tune-challenged crooners have tone deafness, a condition called amusia, which afflicts about 4 percent of the population. Genetic and brain traits

render these folks unable to tell different musical notes apart or to recognize a tune as common as "Happy Birthday." Amusia often — but curiously, not always — results in inept singing. Preliminary evidence suggests that tone-deaf individuals register pitch changes unconsciously, although they can't consciously decide whether one pitch differs from another.

More often, new studies suggest, bad singers hear music just fine. Some can't control their singing voices or align what they sing with what they've heard. Others mistake different sound qualities, or timbres, of voices and instruments for different musical pitches. For them, trying to sing along to someone else's voice — or to, say, a piano — quickly degenerates into an off-key fiasco. An inability to tune up one's voice by first imagining music in the mind's ear can also instigate karaoke catastrophes.

Adding to the cacophony, some tune wreckers can't remember recently heard melodies or even a few musical notes. Scientists are searching for better ways to determine how these and other factors turn singing sour.

"It's hard to measure precisely what a singer is doing," says psychologist Sean Hutchins of the University of Montreal. "Unlike playing a piano, the vocal mechanism is stuffed inside our throats."

Missed pitches

Singing, like speaking, begins when the lungs expel air. In the larynx, or voice box, two fleshy folds — the vocal cords — chop the lungs' output into vibrating air pulses that make sounds with different pitches. The vocal tract — a resonant chamber leading from the vocal cords to the mouth — then provides each sound the additional characteristics of a sung voice.

Each person develops a sense of pitch, a sound's position on a musical scale. Pitch is closely related to, but not the same as, the frequency at which a sound wave vibrates. It's a subjective impression, based not only on sound frequencies but also on family, peer and other cultural influences. The full experience of a musical tone depends on its pitch, duration and loudness.

Researchers have for decades studied acoustic features of professional vocalists' voices, such as the range of notes that they can sing in tune. And music educators have a long-standing interest in figuring out why some people sing in droning monotones. Until the last decade, though, determinations of singing proficiency relied mainly on ratings by seasoned musicians.

Now scientists can measure precise acoustic properties of different musical pitches, such as a G and a C, and assess how close volunteers come to singing those tones after hearing recordings of them played alone, in sequences of notes or in melodies. This task is called pitch matching.

Recent studies indicate that 85 to 90 percent of nonmusicians, and even higher proportions of musicians, accurately imitate single musical pitches, two- to five-note patterns, and unfamiliar as well as familiar melodies. Most participants also sing well-known tunes in key, purely from memory. In these investigations, singers are considered in tune if, on average, they

overshoot (sing "sharp") or undershoot (sing "flat") intended pitches by less than a semitone. (In Western music, a semitone is the minimum distance between two pitches. A semitone represents the acoustic distance from, say, F to F sharp.)

Using the semitone standard, roughly 10 to 15 percent of the population sings badly, says psychologist Simone Dalla Bella of the

Montpellier 1 University, France.

Some singing tasks are harder than others, Dalla Bella notes. Volunteers have a tougher time singing three ascending notes they've just heard than singing "Happy Birthday" accurately from memory. In 2010, a study directed by Pfordresher found that more than half of participants couldn't consistently sing the same pitch accurately on repeated attempts. Volunteers overshoot and undershoot the vocal mark in scatter-shot fashion.

Hutchins suspects that far more

people qualify as bad singers than estimated by Dalla Bella. Given a stricter half-semitone leeway, 25 of 53 musically untrained volunteers regularly sang just-heard musical notes out of tune, Hutchins and University of Montreal colleague Isabelle Peretz reported in 2012.

Even consummate crooners sing slightly off-key, but listeners usually don't notice. Sung notes sound like clunkers only when they miss the mark by a half-semitone or more, says music educator and researcher Steven Demorest of the University of Washington in Seattle. Hutchins and Peretz may be right that poor singers have been undercounted, Demorest says.

Sliding scales

Hutchins and Peretz ferreted out different kinds of bad singers by giving volunteers a novel gadget that produces voicelike sounds by touch. In a series of experiments, musicians and nonmusicians tried to reproduce synthesized, human-sounding musical tones with their own voices and with the finger-controlled device, dubbed a slider.

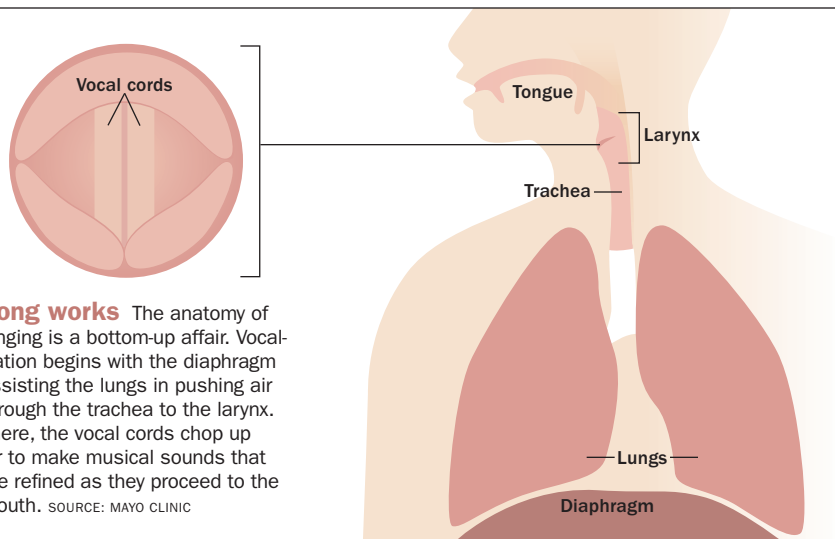
The slider consists of a touch-sensitive strip running along the top of a keyboard-shaped, 38-centimeter-long base. Pressing on the strip generates a musical tone. Moving a finger to the right or left along the strip gradually raises or lowers the tone. A slider's musical range covers an octave, a standard eight-note scale

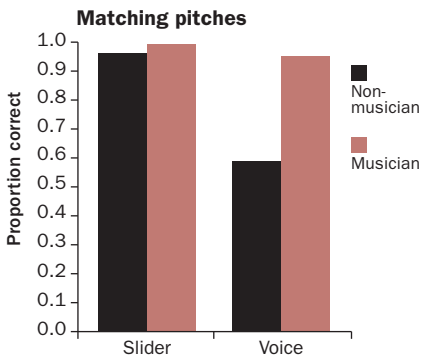
10-50
percent

Range of estimates for portion of population that sings poorly

4
percent

Estimated portion of population that is tone deaf





Sliding up In one study, musicians and nonmusicians accurately re-created musical pitches (left) with a hand-held device called a slider. Singing a just-heard pitch (right) was tougher, especially for nonmusicians.

SOURCE: S. HUTCHINS AND I. PERETZ/J. EXP. PSYCHOL. GEN. 2012

corresponding to “do-re-mi-fa-so-la-ti-do.” Male volunteers used a slider that produced a lower octave than the device given to females.

Both musicians and nonmusicians re-created pitches more accurately with a slider than with their voices, indicating that they heard the difference between musical notes even if singing those notes proved elusive.

Pitch-matching skills varied widely among nonmusicians. More than one-third of them accurately sang synthesized tones in at least 90 percent of the trials. But almost half sang off-key around 50 percent of the time.

Poor singers of both sexes imitated the pitch of their own recorded voices much better than the pitch of synthesized tones. The sound of a familiar, controllable voice apparently helped these individuals tune up, Hutchins suspects. He thinks a singer’s own voice was perceived as being in a different pitch than a slightly different-sounding synthetic voice, even if both voices were singing in the same pitch.

“These people may have more problems singing along with a piano or another musical instrument than with a chorus,” Hutchins says. Vocal teachers might have such students sing along with recordings of their own voices rather than piano tunes, he suggests.

Off-key imaginations

One common technique used by voice instructors is to ask students to imagine

the sounds of particular notes and melodies before singing them. That makes sense, Pfordresher says, given recent evidence that thinking of sounds activates brain areas involved in making sounds.

“Poor singers may fail to generate the kind of vivid auditory images that can be used to plan vocal actions needed for singing accurately,” Pfordresher proposes.

In support of that idea, he and psychologist Andrea Halpern of Bucknell University in Lewisburg, Pa., found that poor singers often, although not always, report hearing little in the mind’s ear. But people who sing in tune tend to report having sensitive inner ears for music, the researchers reported in the August *Psychonomic Bulletin & Review*. Good singers said, for instance, that they can vividly imagine hearing a trumpet play “Happy Birthday” and can mentally transform a choir of children into a choir of adults in an instant.

Anti-American Idols

Unlike William Hung and other wannabe pop stars with delusions of musical talent, most people — competent crooners and tune wreckers alike — think of themselves as lousy singers.

“In our culture, a good singer is usually assumed to be someone like Beyoncé, so we tend to view ourselves as bad singers, even if we’re not,” says Demorest.

Oddly enough, even some tone-deaf individuals who insist that their singing stinks actually carry tunes pretty well. One such woman contacted Hutchins

and Peretz because she was certain her neighbor had amusia. The woman said she had no musical aptitude but liked to sing around the house, despite how terrible it sounded. Yet the wacky neighbor kept complimenting her singing.

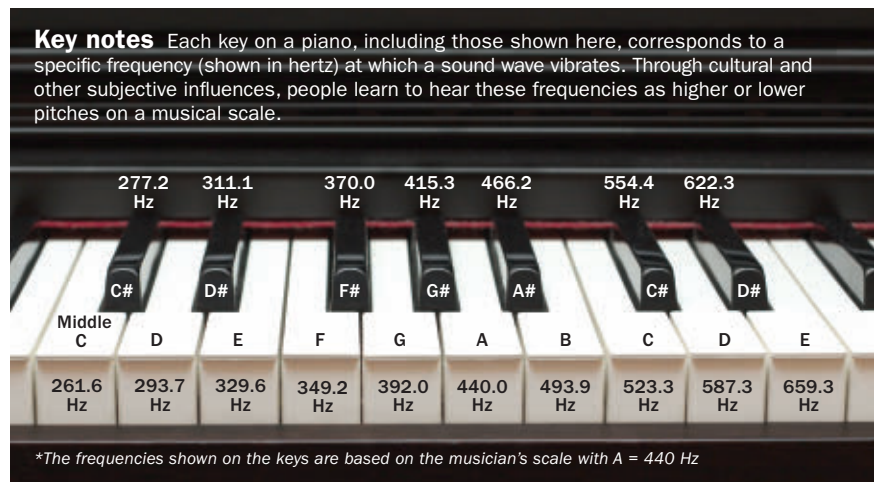
As it turned out, the neighbor was right. Testing confirmed that this woman sang in tune but didn’t realize it. She has a form of amusia that has gone largely unstudied.

In the April *Brain & Language*, Hutchins and Peretz reported that four of nine tone-deaf volunteers sang back recorded musical notes as accurately as nine participants without amusia. Amusiacs who had singing chops adjusted their voices in the correct direction as recorded pitches — either sung or spoken — were digitally tweaked up or down, sometimes so slightly that even volunteers without amusia weren’t aware a pitch had shifted. But the decent tone-deaf singers still overlooked musical pitch changes that were obvious to individuals without amusia.

“Brain mechanisms for pitch production and pitch perception may be largely different,” Hutchins says.

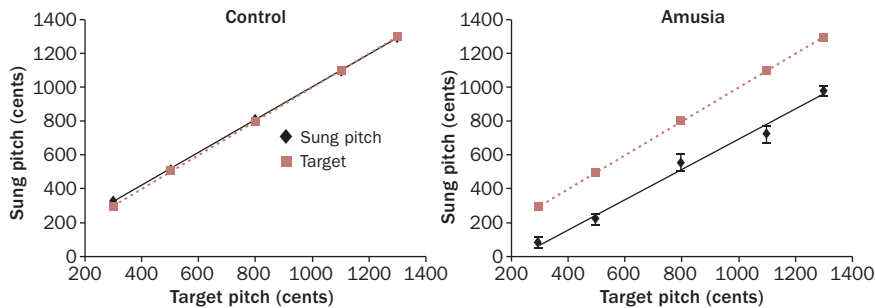
In many cases of amusia, both brain systems malfunction, he proposes. A pathway supporting the act of singing survives in other cases, sparing the ability to carry a tune and to react instantly to subtle pitch changes in another person’s voice.

Related research led by neuroscientist Psyche Loui of Wesleyan University in



*The frequencies shown on the keys are based on the musician’s scale with A = 440 Hz

DYMAX/SHUTTERSTOCK



Missed pitches After hearing ascending musical notes through headphones, people with typical musical abilities usually sang those notes nearly in key (left). A volunteer with amusia, or tone-deafness, sang the same notes consistently off-key (right). The scale bars show pitch differences in cents; 1,200 cents typically equals one octave. SOURCE: S. HUTCHINS ET AL./J. ACOUST. SOC. AM. 2010

Middletown, Conn., and by Peretz, indicates that amusiacs' brains register musical pitches unconsciously. Their brains show no activity indicating conscious awareness of those pitches.

Preliminary evidence suggests that tone-deaf individuals forget melodies shortly after hearing them, adding to their musical woes, Dalla Bella says.

Schooled to sing

Scientists hope that insights into tune wreckers of all stripes will lead to improved techniques for teaching people how to sing. Currently, there is no standard method for making pitch-challenged adults more melodious, Demorest says.

Encouraging children to sing before they grow up and out of tune may hold the most promise. In the United States and other Western nations, around 40 percent of 7-year-olds have difficulty carrying a tune, says music educator Graham Welch of the University of London. That figure falls to roughly 10 percent by age 11 and to no more than a few percent among children who participate in classroom singing programs throughout grade school.

"Once you have developed singing skills as a child, they tend to stay with you, particularly for girls," Welch says. Unlike boys, girls don't have to readjust to a dramatically lower voice during adolescence.

Welch headed a research team that evaluated the singing development of nearly 10,000 primary school students, ages 5 to 12, in England from 2007 to 2010. About 70 percent of the children attended schools participating in

a national singing instruction program called Sing Up.

In those schools, kids attended classes where teachers led students in singing games, voice exercises and sing-alongs of simple tunes.

Sing Up participants sang as well, on average, as youngsters who were two years older but received no instruction. Younger children benefited most from singing classes: 5-year-olds in Sing Up sang as well as 8-year-olds outside the program.

Although researchers have long reported that girls sing better than boys throughout childhood, this sex disparity largely disappeared among Sing Up participants, Welch says.

Babies and toddlers around the world experiment with the pitch of their voices and play singing games with their parents (*SN: 8/14/10, p. 18*). Those who do so regularly are likely to enter school with a basic mastery of their voices, Welch asserts.

Sadly, many adults interviewed by music researchers in North America, the United Kingdom and Scandinavia have described painful childhood memories of being told, often by a choir leader or teacher, that they couldn't sing. Those harsh put-downs fostered an early sense of being a musical failure unable to carry a tune. "Children of all ages can learn to sing if they have appropriate experiences," Welch holds.

Vocal forgiveness

No one, including opera divas and *American Idol* winners, sings every note in perfect pitch. "Absolutely in-tune

singing does not sound human," Welch says. People learn to accept a limited amount of musical mistuning as still being in tune, with vocalists getting an especially big break. Listeners are more likely to call a musical note in tune when it's sung than when it's played on a violin, Hutchins and his colleagues reported in the December *Music Perception*.

Among nonmusicians, sung tones needed to be mistuned by at least twice as much as violin tones to be judged as out of tune. A professional opera singer could drift off-key by roughly half the acoustic distance from, say, F to F sharp before volunteers said she was hitting a clunker. A trained violinist could veer off-key only about one-quarter of the way from F to F sharp before getting bad reviews.

Musicians recruited for the study reported a smaller range of acceptable tuning than nonmusicians did but still gave considerably more leeway to a singer than a violinist.

This finding, which the researchers dub the vocal generosity effect, may explain the well-established tendency for singers to be less in tune than instrumentalists. Hearing many more mistuned voices than musical instruments in one's lifetime might prompt a charitable ear for singing errors.

Still, hard-core tune wreckers shouldn't hold their breath waiting for an audience's vocal generosity to kick in. Belting out a star-spangled mess in the key of shriek marked Roseanne as disrespectful. William Hung enjoyed a moment of fame because his inept song-and-dance routine was entertainingly mockable.

As for the "My Way" killings, die-hard Sinatra fans apparently have less patience with bad singers than the Chairman of the Board did. ■

Explore more

- International Laboratory for Brain, Music and Sound Research: www.brams.org/en/
- Peter Pfordresher's website: www.acsu.buffalo.edu/~ppq/members.html

Behind the Shock Machine

Gina Perry

In 1963, Yale psychologist Stanley Milgram reported an appalling discovery: 65 percent of volunteers would deliver electrical shocks to another person at levels they believed were lethal if an experimenter asked them to. Ordinary people, it seemed, could easily be convinced to do monstrous things by authority figures.

The famous obedience experiment resonated in postwar America, where the trials of Nazi officers were fresh in the public mind. Milgram’s work lent scientific credibility to fears about the human capacity for cruelty, says science writer Perry.

But in the 50 years since, much of Milgram’s science has been lost in the sensationalism. Perry examines notes and archived audio tapes to piece together an accurate account of the experimenter’s methodology. Milgram selected his data carefully and downplayed inconsistencies in his publications, she says. For instance,

he performed not one but 24 versions of the shock machine scenario, altering variables such as whether screams were audible or asking people to shock family members. In many of these variations, more than 60 percent of subjects disobeyed the experimenter’s directions.

Perry offers no easy answers as to what Milgram’s work can or can’t teach



about human nature. But she does present a more complete picture of a captivating and often misunderstood experiment. The book also provides an unflinching biography of

Milgram himself: a scientist who eagerly promoted his controversial research but who may have understood the limitations of his findings better than anyone.

“Whether all of this ballyhoo points to significant science or merely effective theater,” he once wrote, “is an open question.” — *Allison Bohac*

The New Press, 2013, 339 p., \$26.95

The Nazi and the Psychiatrist

Jack El-Hai

On New Year’s Day in 1958, after a screaming fight with his wife, U.S. Army psychiatrist Douglas Kelley grabbed a poison pill from his study, shoved it into his mouth and swallowed.

So begins journalist El-Hai’s investigation into the mind of the man who sought to understand the minds of Nazis. At World War II’s close, Kelley, head of psychiatric services at a military hospital, was given a new task: preserving the mental health of Nazi leaders awaiting trial.

To this task Kelley tacked on a secret mission. He wanted to ferret out what made these men tick — to find some mental seed shared by the criminals. What he found haunted him: Nazi leaders were not insane or even unusual. After months

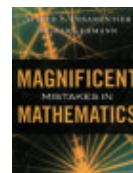
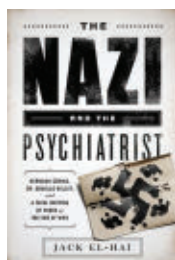
of psychological testing, Kelley determined that the Nazis shared two traits: They were goal driven and tireless workaholics. “Their like could very easily be found in America,” he wrote.

That knowledge may have led Kelley to suicide, El-Hai suggests. Twelve years after leaving the trials in Germany, he killed himself with the same poison one of his patients, top Nazi Hermann Göring, took before he was to be hanged.

After his psychological analyses of Nazis, Kelley worried that such atrocities could recur. His work had convinced him that people with the killers’ traits, combined with ambition and excessive patriotism, could be similarly corrupted.

With full access to Kelley’s notes on Nazi psychology, El-Hai infuses his story with the messy, compelling details of people’s lives. These tug the reader inside Kelley’s head for an engrossing exploration of human nature, sanity and despair. — *Meghan Rosen*

PublicAffairs, 2013, 304 p., \$27.99



Magnificent Mistakes in Mathematics

Alfred S. Posamentier and Ingmar Lehmann

Advanced math skills are not required to enjoy untangling errors that illustrate concepts in arithmetic, algebra and more. *Prometheus, 2013, 300 p., \$24*



Identically Different

Tim Spector

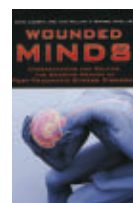
The head of a project following the health of 12,000 twins explains how environments create differences in genetically identical twins. *Overlook Press, 2013, 352 p., \$26.95*



Ninety Percent of Everything

Rose George

This look inside the shipping industry reveals a little-seen world with deep impacts on the environment. *Metropolitan Books, 2013, 304 p., \$28*



Wounded Minds

John Liebert and William J. Birnes

A writer and a psychiatrist tell stories of people with post-traumatic stress disorder and describe the neuroscience behind the problem. *Skyhorse Publishing, 2013, 316 p., \$24.95*



Invasive Species

Daniel Simberloff

A noted ecologist surveys biological invaders and their effects on economies and the environment. *Oxford Univ., 2013, 352 p., \$16.95*

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No thanks to glowing plants

Omri Amirav-Drory is a menace to dark skies (“A glowing green thumb,” *SN*: 8/24/13, p. 32). Although way too few cities or towns use them, full-cutoff street lights — which project light only downward, where it’s needed — do exist. Glowing trees will certainly project in every direction, both wasting lumens and aggravating light pollution. If these trees become a reality, and if my town considers planting them, you can be sure I will oppose the move. Keep the glowing plants as curiosities in botanical gardens and protect us from dreamers and visionaries.

K.A. Boriskin, Bellingham, Mass.

There is a problem with using glowing trees to light cities: light pollution. Sky watchers are already up in arms over poorly aimed lighting (see, for example the International Dark-Sky Association,

www.darksky.org), and glowing trees as shown in the illustration would certainly qualify. Fortunately there’s a simple solution: Genetically engineer the trees so only the undersides of the leaves glow, aiming the light downward where it is useful. This should be fairly easy to do since the top and bottom of leaves are often different.

Bobby Baum, Bethesda, Md.

Quakes and fracking

It is not the wells that cause earthquakes we should be worrying about (“Huge quakes foretell smaller ones,” *SN*: 8/10/13, p. 16); it is the ones that don’t. If a well causes earthquakes, it is injecting into a pressure compartment that is strong enough to allow pressure to build. If that doesn’t happen, the pressure compartment is weak, circulating injected fluids more broadly. Once this happens, these fluids are at the whim of the basin’s hydrologic system. We need to rethink the long-term

safety of the entire injection process. If that slows down fracking, so be it. It is being drilled up so fast it will be in severe decline in only about 20 years. That shortfall will help no one, not even the oil companies.

John Sales, Barre, Vt.

Space party

I might have been feeling a bit spacey this morning at 2 a.m. while I read “How molecules hook up in space” (*SN*: 8/10/13, p. 9) about the discovery that alcohols and sugars are among the organic chemicals floating in interstellar space. What a thrill imagining all that free moonshine and candy wafting around up there! Keep up the good work, astronomers, and perhaps we *will* have pie in the sky, by and by!

Shelley Goldbloom, Corbin, Ky.

Send communications to: Editor, Science News, 1719 N Street, NW, Washington, D.C. 20036 or editors@sciencenews.org. Letters subject to editing.

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Marketplace



Researchers Bruce Mate (right) and Al Goudy prepare to tag a blue whale off Costa Rica.

Seeking the loneliest whale

An enigmatic whale roams the North Pacific, and next year Bruce Mate will lead a month-long expedition to find it. Mate, director of Oregon State University's Marine Mammal Institute in Newport, is no revenge-obsessed Captain Ahab. And the object of the quest is no ferocious leviathan: It is probably one of the generally meek baleen whales that prey on creatures close to the base of the food chain.

No one has ever seen this particular whale ("that they know of," says Mate), but researchers know it's out there. Its distinctive 52-hertz calls — similar to those of blue

whales and fin whales but higher in pitch — have been recorded since 1989 by various researchers and the U.S. Navy.

Scientists have some notions about the mystery whale: It's probably a male, says Mate, since its calls pierce the seas only during mating season. The whale has been tracked swimming as far as 11,000 kilometers in a single season, so it's apparently healthy. Because the whale's path doesn't seem to line up with those of other species inhabiting the same region, the cetacean has been dubbed by some "the loneliest whale in the world."

Mate doesn't buy that moniker for a number of reasons. For one thing, he says, females typically don't respond vocally to a male's mating calls; they simply show up, so scientists would not have heard them. He also doesn't think it's the last member of an unknown species hunted to near extinction. Instead, it's more likely to be a hybrid between two known species, or possibly an individual with a malformation in its sound-producing organs — the cetacean equivalent of a lisp. "It wouldn't surprise me to find a large number of other whales in his vicinity when we find him."

In fact, Mate is counting on it. Although the expedition will be funded by a team of documentary filmmakers searching specifically for the falsetto whale, Mate hopes to tag about a dozen other whales. That will give him a rare chance to learn what whales do between feeding season, when they gorge themselves to build up fat stores, and breeding season.

"We're trying to track these whales from the season we know to the season that we don't," he says. "There hasn't been an experiment yet where we didn't have 'an 'a-ha' moment.'" — *Sid Perkins*



Whale hide-and-seek

Marine biologist Bruce Mate and his colleagues have pioneered techniques for tagging whales with hockey puck-sized instrument packages to track migratory and feeding habits. Here are a few examples of what they're learning from tagging data about whale behavior and populations.

Eddy feeding

Baleen whales sometimes seek out and follow large, kilometers-wide ocean eddies and feed within them or along their edges, taking advantage of biological hot spots that are created as eddies bring cold, nutrient-rich waters to the surface.

Tag-team hunting

Sperm whales, which normally forage alone for prey such as giant squid, occasionally hunt in tag teams. One whale dives deep to prevent prey from escaping downward while its companions herd the animals into dense schools and then lunge into the feast.

Oil spill-related detours

Mate and his colleagues are now collecting data that could reveal whether the massive 2010 Deepwater Horizon oil spill has substantially affected sperm whales' migratory and feeding patterns in the northern Gulf of Mexico.

Enjoy A Bath Again... Safely and Affordably



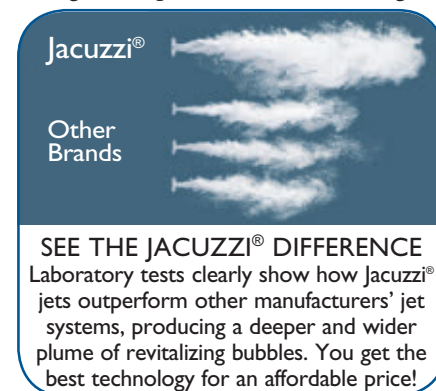
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EXPERIENCE THE LUXURY OF MITSUKO ORGANIC CULTURED PEARLS REGULARLY \$299, GET THEM TODAY FOR **FREE***

We owe you an apology. This exclusive deal is guaranteed to ruin every jewelry purchase you make from now on. Once you realize that it's possible to own a genuine cultured pearl necklace for **FREE**, other luxury brands are bound to disappoint. They can't handle **FREE** jewelry. They can't even afford to try. But you can. And that's all that matters to us.

We're offering our *Mitsuko Organic Cultured Pearl Necklace* online for \$299. But if you'd like it for near **NOTHING** (you pay only the \$19.95 shipping & processing—see details below) all you need to do is call 1-800-859-1542.

It's okay to be skeptical. You have every right to be. Why would any company give away a pearl necklace? Good question. We believe that once you try us, you'll be back for more. But maybe a better question is why other luxury jewelers don't think twice about offering cultured pearls for hundreds—even thousands—more. I'm sure they have their reasons. But you don't have to fall for them. Not anymore. Call today for your **FREE Mitsuko Organic Cultured Pearl Necklace** and you'll realize that luxury doesn't have to cost a fortune.



By implanting a nucleus inside the oyster, farmers stimulate the natural creation of a pearl. Each Mitsuko cultured pearl is harvested, polished and strung by hand.

Mitsuko Organic Cultured Pearls—Exclusively from Stauer. Every necklace is the product of generations of expertise. From natural genesis to final selection, imported Mitsuko organic cultured pearls are held to the highest standard. This continuous, 26" strand showcases a collection of 6½-7mm white cultured pearls. Each necklace is hand-strung and double-knotted to keep every precious pearl secure.

This exclusive FREE offer can't last forever. Unfortunately, we are only able to make a limited number of these necklaces available to the public for free. Don't let this incredible opportunity pass you by! To ensure that you receive your **FREE Mitsuko Organic Cultured Pearl Necklace**, please call today. Your idea of luxury will never be the same!

Mitsuko Cultured Pearl Necklace
Regularly ~~\$299~~†

Yours FREE*

*Pay only \$19.95 shipping & processing

Stauer®

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Dept. MFP134-01
Burnsville, Minnesota 55337 www.stauer.com

† Free is for Call-In Customers only versus the original Stauer.com price.



Call now while our supplies last...

1-800-859-1542

Promotional Code MFP134-01
Please mention this code when you call.

Smart Luxuries—Surprising Prices™

* This offer is valid in the United States (and Puerto Rico) except in TX, FL, CO, OK, RI, NH, WV and ID. These state residents will be charged one cent (\$.01) + shipping & processing for the item. Void where prohibited or restricted by law. Offer subject to state and local regulations. Not valid with any other offers and only while supplies last. This offer is limited to one item per shipping address.