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SCIENCE NEWS MAGAZINE
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Playing
Brain
Games for
Science

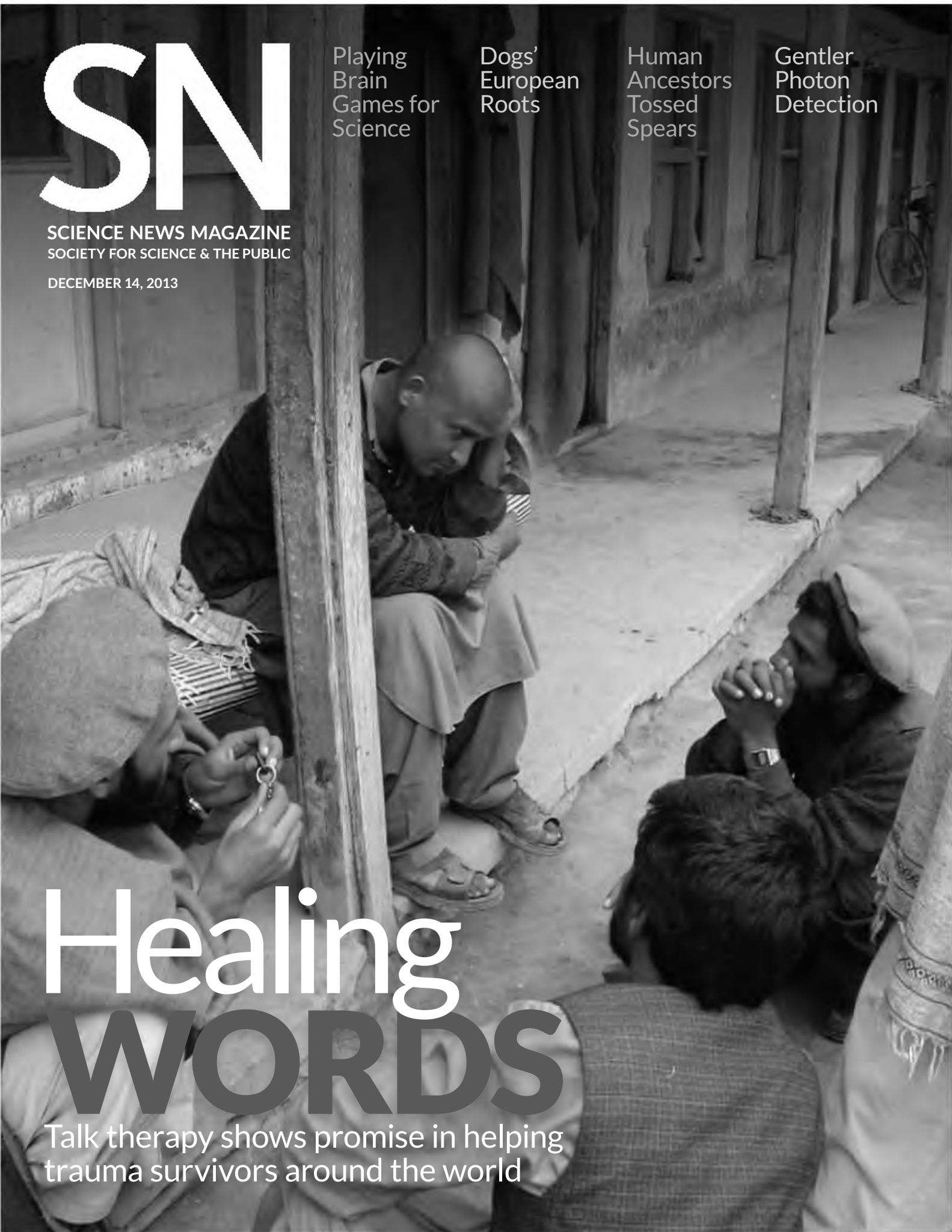
Dogs'
European
Roots

Human
Ancestors
Tossed
Spears

Gentler
Photon
Detection

Healing WORDS

Talk therapy shows promise in helping
trauma survivors around the world



ScienceNews

Features

18 Global Neuro Lab

With more than 50 million users, the brain-training website Lumosity is giving scientists access to an enormous collection of cognitive performance data. Mining the dataset could be the first step toward a new kind of neuroscience. *By Laura Sanders*

22 Heal Thy Neighbor

COVER STORY As antidepressants and other drugs gradually replace psychotherapy in the United States, new forms of the talking cure are growing in popularity in developing countries ravaged by civil war and poverty. *By Bruce Bower*

18

News

6 Domesticated dogs descended from European ancestors more than 18,000 years ago.

7 Changes in a malaria parasite may allow the pest to infect Africans normally protected from the disease.

8 Seawater from the early Atlantic Ocean has been trapped in sediments beneath the Chesapeake Bay for at least 100 million years.

Injecting greenhouse gases into the ground to mitigate climate change could trigger earthquakes.

9 Physicists find a way to detect a single photon without destroying the light particle.

10 Newborn immune suppression allows helpful bacteria to colonize infants.

Inflammatory disorders may develop when people's circadian clocks get disrupted.

12 Using sex organs as syringes, sea slugs (below) inject compounds into their mates' heads.

A newly discovered prion disease attacks the intestines years before it starts attacking the brain.

13 Stress during pregnancy alters a mother mouse's mix of bacteria, ultimately influencing brain development in her pups.

14 Projectile weapons may predate *Homo sapiens*.

Computer games suggest why cultural innovations occur faster in large groups.

16 News in Brief

Penguins' migration out of Antarctica dated, a bone marrow transplant cures a peanut allergy, volcanic activity under West Antarctica may fuel sea level rise and more.



12



32

Departments

2 EDITOR'S NOTE

4 NOTEBOOK

The orchid mantis uses a flowery subterfuge to lure prey.

28 REVIEWS & PREVIEWS

Astronaut Chris Hadfield talks about the odd and the ordinary in space.

30 FEEDBACK

32 SCIENCE VISUALIZED

Satellites track Earth's forests down to the scale of a suburban yard.

COVER Afghan men participate in a counseling session. Community-based talk therapy is spreading in the developing world. *Peter Ventevogel/HealthNetTPO*

Exploring dog origins with data and a dose of imagination



The story ends with a dog curled up at the foot of a bed, having been fed and patted by its owner. But exactly how the canine-human relationship began is a mystery. When and where were dogs first domesticated? For what purpose? How different are they from their fiercer canine relatives, the wolves?

Some clues can be gleaned from dogs and wolves themselves, as well as from fossils of early canids. And in the last decade or so, genetic data have come into play. A 2002 study showed that the greatest genetic diversity in living dogs and wolves (as measured in the mitochondrial genome and later in the Y chromosome) exists in southern East Asia. That led some to finger that region as the birthplace of dogs. But a 2010 study, which used a different kind of genetic analysis to look at 48,000 gene markers in living animals, suggested a close relationship between dogs and Middle Eastern wolves.

A new study, reported by molecular biology writer Tina Hesman Saey on Page 6, offers a third option — Europe. An analysis of mitochondrial DNA taken from ancient doglike and wolflike fossils shows that living dog species are most closely related to a line of wolves that once roamed Europe.

Scientists estimate that dogs emerged as a distinct subspecies more than 18,000 years ago, before the dawn of farming. Which gets us to the question of just why and how dogs first became human companions. If dogs were domesticated by hunter-gatherers, they might have been bred to aid in hunting, for example.

Speaking at the New Horizons in Science meeting on November 3, Clive D.L. Wynne had another idea about how dogs originated. Wynne, a psychologist at Arizona State University in Tempe, thinks it was not initially a human-driven process. Instead, he proposes that dog ancestors started out as scavengers at human trash heaps. Lured by an easy meal, the dogs may have wandered closer and closer to humans. These people might have seen dogs' utility — perhaps as lookouts with an intimidating bark. Dogs might also have been valued as a source of protein. Random genetic changes may have helped increase mutual toleration between the species. One gene mutation found in dogs but not wolves also turns up in people with a disorder marked by an outgoing and friendly personality, Wynne said. This might have enabled dogs to help on the hunt, and eventually led to interspecies affection.

Wynne is openly speculating. But that's OK. To get to the bottom of the story we'll need to use all the clues we have, plus a healthy dose of imagination. — *Eva Emerson, Editor in Chief*

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Excerpt from the
December 14, 1963,
issue of *Science
News Letter*

50 YEARS AGO

New Atomic Accelerator

A new atom smasher for probing the inner cores of atoms, one of the three largest of its type in the world, is now in full operation at Argonne National Laboratory, Argonne, Ill. The atomic accelerator, called the ZGS for Zero Gradient Synchrotron, will accelerate protons to 12.5 billion electron volts, then hurl them at target atoms in an extremely intense beam. An aerial view of the central portion of the facility, dedicated Dec. 4, is seen on this week's front cover.... The speeding protons are being used to learn more about the structure of protons themselves and other nuclear particles.

UPDATE: Argonne's proton accelerator had a bubble chamber, used to detect charged particles, that was the first such device to detect a neutrino. The synchrotron ran until 1979. The lab has since developed the Advanced Photon Source, which accelerates electrons to near the speed of light to generate X-ray beams used in particle physics and more.



A female orchid mantis does a near-perfect floral imitation, fanning out her petallike legs as she clings to a twig.

SAY WHAT?

Cryovolcano \KREYE-oh-vahl-cayn-oh\ n.

An ice volcano that erupts slurries of volatile compounds such as water or methane instead of lava. Cryovolcanoes are thought to occur in the solar system's frozen places, such as Saturn's largest moon Titan, where such volcanoes may spew liquid from an ocean hidden in the moon's interior. On Titan's frigid surface, astronomers have spotted formations (left) that resemble volcanic features on Earth, such as lava flows and craters. Data captured by the Cassini spacecraft from 2005 to 2009 revealed changes in surface brightness in regions with these structures, a sign of ongoing cryovolcanism on Titan, Anezina Solomonidou of the Paris Observatory reported in September in London at the European Planetary Science Congress. — *Erin Wayman*



THE -EST

Oldest fossil bug sex

In the Middle Jurassic, two froghoppers (*Anthoscytina perpetua*) came together in a dance as old as time. But before they finished, death came knocking. The pair was buried and has remained preserved for 165 million years. Researchers in China found the specimen among 1,200 fossils at a site in Inner Mongolia, as described November 6 in *PLOS ONE*. The insects would have been easy to miss; each measures only 15–17 millimeters long. Their mating position is similar to the side-by-side pose of modern froghoppers, showing that at least some things haven't changed much in 165 million years. — *Bethany Brookshire*



FROM TOP: ROGER MEERTS/SHUTTERSTOCK; USGS ASTROGEOLOGY SCIENCE CENTER; S. LI ET AL./PLOS ONE 2013

IT'S ALIVE

A corsage that bites

Orchid mantises have evolved into a fake flower that out-flowers the real thing. The insects don't seem to be mimicking any real flower found so far, but have invented something even fancier.

Among the many oddly shaped mantises of the world, only the petal-legged, corsage-worthy orchid mantis (*Hymenopus coronatus*) comes close to counterfeiting a whole blossom, says James O'Hanlon of Macquarie University in Sydney.

Which can be a nuisance. Searching rainforests for orchid mantises to study is "very frustrating," O'Hanlon says. "Every time you see a flower you go nuts thinking you've found one, and then it's just a flower."

This resemblance led Alfred Russel Wallace, the largely forgotten also-ran

of evolutionary theory, to propose that the phony flowers lure a pollinator close enough to grab in an eye-blink strike. (They can rip apart a butterfly thrice their size.) O'Hanlon was shocked

to discover, though, that this oft-mentioned idea had never been tested. He and his colleagues began scouring Malaysian rainforests for wild orchid mantises.

"As far as we can tell, they're fantastically rare," O'Hanlon says. People living in the rainforest brought some to the researchers, he says, but "it took over a month to find one myself."

That fits with theory, which suggests deceitful mimics should be rare or else their victims would catch on. Other evidence also fits Wallace's idea,

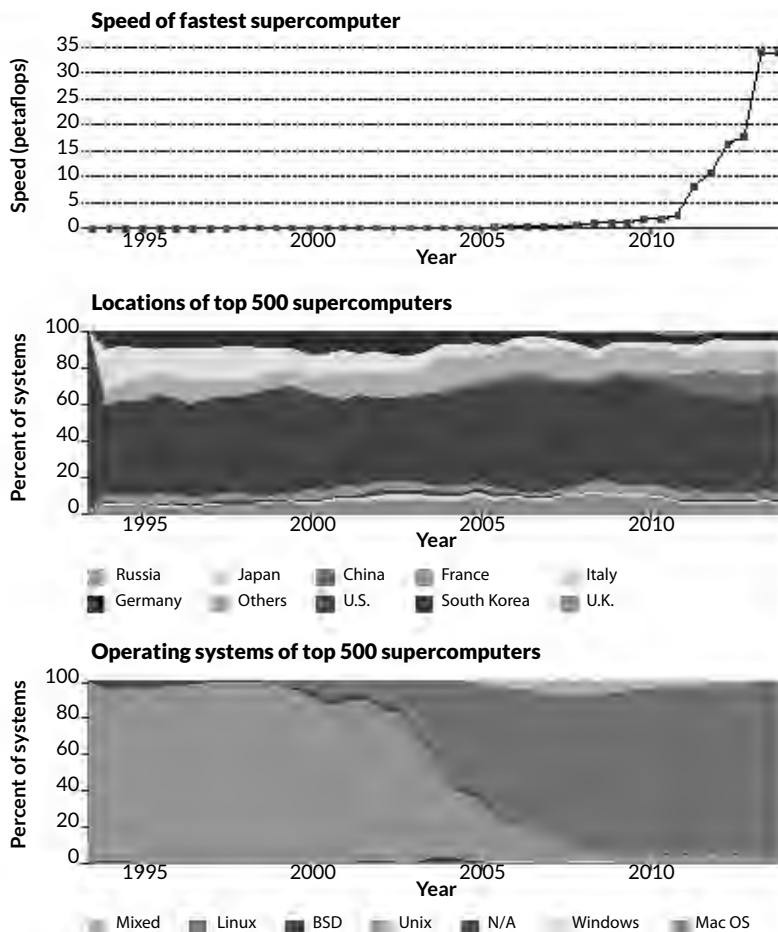
O'Hanlon and his colleagues report in the January 2014 *American Naturalist*. Orchid mantises' colors fall within the range of 13 local flower species, according to computer models that simulate

what colors bees actually see. And when researchers set orchid mantises out in the forest, local bees, flies and butterflies flew fatally close (left).

The mantises, in fact, attracted more pollinators than real flowers did. O'Hanlon has yet to find a flower that

the mantis looks very much like. Yet it fooled Australian journalist James Hingsley so thoroughly in 1879 that he reported it as a real orchid "that catches and feeds upon live flies."

— Susan Milius



SCIENCE STATS

Fastest supercomputers

The new list of the world's fastest computers, now in its 20th year, has China's Tianhe-2 on top with a processing speed of 33.9 petaflops — or quadrillions of calculations per second. Many top supercomputers are at national laboratories and are used mainly for science, such as number two Titan at Oak Ridge National Laboratory in Tennessee. In recent years, speeds have risen dramatically and operating systems have switched to Linux, prized by researchers for its flexibility.

SOURCE: TOP500.ORG

Speed gap

33.9
petaflops

Speed of Tianhe-2,
world's fastest supercomputer

17.6
petaflops

Speed of Titan,
second-fastest supercomputer

Modern dogs originated in Europe

First domesticated canines did not live in China or Middle East



A 36,000-year-old dog fossil from Belgium's Goyet cave was once thought to be an ancestor of modern breeds, but new DNA evidence suggests that the dog did not leave behind any living descendants.

BY TINA HESMAN SAEY

Dogs and humans became best friends in Europe more than 18,000 years ago. That's the conclusion of a genetic study of dogs and wolves, both ancient and modern.

The time and place of dog domestication have been hotly debated, with genetic studies and archaeological finds often seeming to contradict each other. Fossils from Europe suggest doglike creatures have existed there for about 30,000 years. But some genetic analyses place the origins of domestic dogs in China or the Middle East (*SN: 4/10/10, p. 12*). Previous genetic studies have compared DNA from living dogs and wolves, but those efforts generally did not include ancient DNA.

Now Olaf Thalmann of the University of Turku in Finland and colleagues have examined genetic material from fossil dogs and wolves, as well as from living animals. "The genetics point toward Europe" as the center of canine domestication, Thalmann says. Hunter-gatherers domesticated dogs from European wolves between 18,800 and 32,100 years ago, the researchers report in the Nov. 15 *Science*.

"This is older than farming," says coauthor Beth Shapiro, a paleogeneticist at the University of California, Santa Cruz. The team also found evidence

suggesting that dogs accompanied the first people to settle in the Americas.

The study is a big step forward in understanding how dogs came to live with humans, says evolutionary biologist Greger Larson of Durham University in England. A better understanding of dog domestication could give researchers insight into the minds of ancient people who, after nearly 200,000 years of going it alone, took animals as companions. Domesticating wild canids might have primed conditions for pastoralism and set the stage for other innovations, Larson speculates. "Part of me wonders, if you didn't have dogs, how much longer would it have taken to domesticate other animals?" he says.

In the study, the researchers examined mitochondrial DNA from 18 ancient canids. Analyzing DNA from mitochondria, energy-producing organelles that females pass to their offspring, allows researchers to trace maternal ancestry.

The ancient DNA data were compared with mitochondrial DNA from 49 wolves, 80 dogs of various breeds and four coyotes. Dogs, the team found, fall into four major mitochondrial lineages. Those four groups are more closely related to ancient European wolves than to living ones, lending support to a report this year that a now-extinct wolf may be the ancestor of dogs (*SN: 7/13/13, p. 14*).

Some of the ancient dogs, namely a 36,000-year-old fossil called the Goyet dog from Belgium and a 33,000-year-old fossil dog from Siberia's Altai Mountains, don't have any modern dog descendants, possibly indicating failed attempts at domestication.

That result doesn't surprise Susan Crockford, a zoologist and evolutionary biologist at the University of Victoria in Canada. "The idea of multiple domestication events, with some of them perhaps being dead ends, is essential to the dog origins story," she says. Other animals, including pigs, sheep and cattle, were independently domesticated many times. Dogs are probably no different, with multiple domestication pushes in Europe and Asia. But only European dogs seem to have given rise to modern breeds.

Dog domestication probably wasn't a deliberate act, Crockford says; rather, conditions created by people living in permanent settlements would have allowed wolves to naturally develop doglike physical and behavioral characteristics. That makes her question the dates in the new study because she says Ice Age hunter-gatherers were too mobile to have forged the ecological conditions necessary for such a transformation.

The researchers acknowledge that they traced only maternal heritage. "Mitochondria give a limited vision of what has happened," Thalmann says. Some of his colleagues are attempting to isolate DNA from ancient specimens' cell nuclei, where the main bulk of genetic instructions are stored. "Nuclear DNA might have some very interesting surprises, but we can't foresee them," he says.

Larson doesn't expect dogs' nuclear DNA to tell a completely different domestication tale, "but it will be a considerably more nuanced one." ■

Changes in malaria parasite may make Africans more susceptible to infection

Genetic protection from *Plasmodium vivax* may be in jeopardy

BY NATHAN SEPPA

WASHINGTON — A form of malaria largely absent in sub-Saharan Africa has begun to make inroads there. Ominous signals are emerging simultaneously in population studies and under the microscope that *Plasmodium vivax*, a malaria parasite well known in Asia and Latin America, may have found a way to infect Africans. Researchers presented the results November 15 at the annual meeting of the American Society of Tropical Medicine and Hygiene.

Most sub-Saharan Africans outside Ethiopia carry a genetic trait that makes it hard for the vivax protozoan to infect them. These people lack a receptor protein on their red blood cells called the Duffy protein. Missing this protein doesn't seem to cause health problems. Rather, it's a plus because *P. vivax* hijacks the Duffy protein to gain entry into red blood cells and commandeer them.

Didier Ménard of the Pasteur Institute in Phnom Penh, Cambodia, presented data from Madagascar revealing that vivax malaria that evades people's genetic protection is showing up in the island country. Ménard and his colleagues found that, among blood samples from 183 people in Madagascar who

had vivax malaria, 9.3 percent lacked the Duffy protein, suggesting those people should have been protected against a vivax infection.

The finding follows recent reports of vivax cropping up in Duffy-negative people in Angola, Mauritania, Kenya, Equatorial Guinea and most recently Ethiopia, said molecular biologist Peter Zimmerman of Case Western Reserve University in Cleveland.

Meanwhile, lab work has shown that some *P. vivax* parasites have developed a duplicate version of the gene encoding the protein that the parasite uses to bind to the Duffy protein. Geneticist David Serre of the Cleveland Clinic and others obtained 189 samples of vivax malaria parasites that had infected people in Madagascar and found 100 with the gene duplication.

Zimmerman hypothesized that a parasite armed with such a duplicate gene might be able to infect Duffy-negative people. Perhaps the duplicated gene generates so much of the binding protein that it can somehow get into a red

blood cell, Serre said.

Serre and others plan to investigate that possibility. The key will be to screen Duffy-negative individuals who are in the throes of a vivax infection, Serre said, and examine red blood cells to see if there are a lot of these binding proteins resulting from the duplication. In essence, the researchers hope to catch the unusual parasite in the act.

"It's the same story over and over again in evolution," said David Walker, a physician at the University of Texas Medical Branch at Galveston

and past president of the American Society of Tropical Medicine and Hygiene. "Something is finding a way to expand its population." In this case, the parasite may have found a new strategy.

If an altered vivax were to spread widely in sub-Saharan Africa, the consequences could be worrisome, the researchers said. The most common and severe malaria in Africa is caused by the *Plasmodium falciparum*

parasite. While vivax is not as dangerous, it can still be lethal. What's more, it has a dormant stage that makes it hard to treat. "When infected with *P. falciparum*, you're in bed, you're sick and not going anywhere," Serre said. "With vivax, you're sick but you get treated and feel better and you travel." This could worsen spread of the altered parasite. ■

1.97
million

Vivax malaria cases reported in 2011

<1
percent

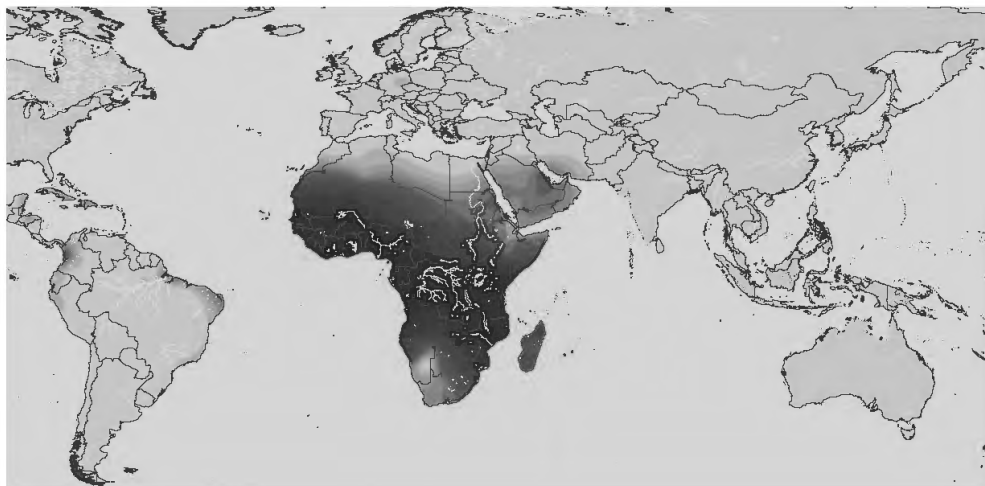
Fraction occurring in sub-Saharan Africa, not including Ethiopia

SOURCE: WHO

Duffy negative The swath of dark red across Africa shows the densest concentration of people who lack the Duffy protein on their red blood cells. The Duffy protein allows the malaria parasite *Plasmodium vivax* to invade cells and infect a person. A genetic trait that causes people to lack the protein protects most Africans against this kind of malaria. But new research finds the safeguard might be threatened by an unusual form of the parasite.

Percent of Duffy-negative people

0 100



EARTH & ENVIRONMENT

Relic seawater reveals saltier past

Sediments off East Coast hint at Atlantic Ocean's early history

BY JESSICA MORRISON

Water, water, everywhere and some of it has been undisturbed for more than 100 million years.

Groundwater from sediments below the mouth of the Chesapeake Bay may be 100 million to 145 million years old. The ancient samples, twice as salty as modern seawater, were already trapped in sediments when an asteroid or comet landed in the area some 35 million years ago, researchers report in the Nov. 14 *Nature*.

Similarly salty water in sediments off the Atlantic coast of Georgia, Maryland, North Carolina and New Jersey could be just as old, but no one has sampled them carefully enough to find out, says Ward Sanford, a hydrologist at the U.S. Geological Survey in Reston, Va. During the last decade, the USGS with the International Continental Scientific Drilling Program drilled a deep hole in the Chesapeake Bay impact crater to figure out how the asteroid strike changed Earth's crust. What they found in early test wells surprised them: water with salinity much higher than that of the modern ocean.

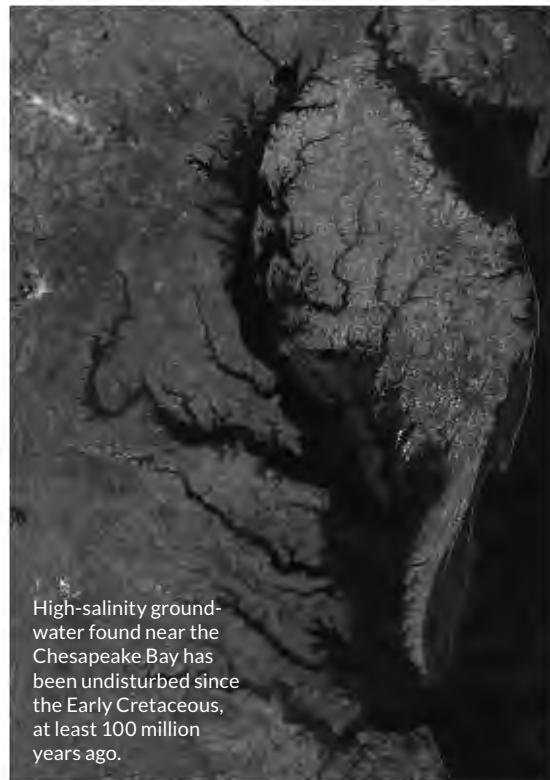
Later Sanford and his colleagues analyzed water in the cores and found evidence that the water has been undisturbed since the Early Cretaceous,

a geologic epoch running from about 145 million to 100 million years ago. One way the researchers estimated the age was with measurements of the water's helium concentration, which increases the longer water is isolated from the atmosphere.

The ancient water was trapped in seafloor sediments that built up in the incipient North Atlantic Ocean, which was almost completely closed off from the rest of the world's oceans at the time.

"There haven't been any conditions that would have driven the water out of the system," Sanford says. "And for the diffusion that occurs naturally, there hasn't been enough time."

The age of the seawater could explain an anomaly: higher than normal salinity in some groundwater along the Eastern Seaboard. The researchers suggest that during the Cretaceous, when the North Atlantic was evolving from a closed basin to an open ocean, the Atlantic's water was saltier. In a closed basin, salinity increases because the amount of water that comes in through precipitation is less than the amount that leaves through evaporation, which leaves behind salt. Sanford's team determined the ancient seawater had a salinity twice that of



High-salinity groundwater found near the Chesapeake Bay has been undisturbed since the Early Cretaceous, at least 100 million years ago.

modern seawater.

Today, the Mediterranean Sea is a nearly enclosed basin, connected to the Atlantic by only the Strait of Gibraltar. Its salinity is around 10 percent higher than typical ocean water.

Richard Norris, a paleoceanographer at the Scripps Institution of Oceanography in La Jolla, Calif., who is familiar with the unusually high salinity of sediments underlying the Chesapeake Bay, says the research is important for understanding groundwater resources.

"What it does tell you," he says, "is that the water dates from around the time when the Atlantic began to open." ■

EARTH & ENVIRONMENT

Earthquakes tied to gas injections

Sequestering carbon dioxide underground could create hazards

BY BETH MOLE

Pumping carbon dioxide into the bowels of the Earth seems like an appealing way to get rid of the greenhouse gas. But such injections could trigger earthquakes, geophysicists report November 4 in the *Proceedings of the National Academy of Sciences*.

Petroleum companies already use CO₂ injections to flush out underground oil. Now researchers have found that such

gas injections into a Texas oil field sparked dozens of small earthquakes.

"It's inconceivable that the injection wells weren't contributing to these earthquakes," says study coauthor Cliff Frohlich of the University of Texas at Austin. The study provides some of the first evidence that gas injections lead to earthquakes.

For decades, scientists and engineers have known that injecting some fluids

such as waste from hydraulic fracturing, or fracking, can alter underground stresses and lead to moderate earthquakes. But scientists knew little about the effects of injecting gases such as CO₂. (Both of these practices are distinct from fracking itself, which is generally not a cause of earthquakes.)

In recent years, some researchers have proposed using injections to store greenhouse gases underground and slow climate change.

Frohlich and Wei Gan of the China University of Geosciences in Beijing found that from 2006 to 2011, nearly 150 earthquakes occurred at or very

Photon detected but not destroyed

Instrument can identify a light particle without absorbing it

BY ANDREW GRANT

Physicists have seen a single particle of light and then let it go on its way. The feat was possible thanks to a new technique that, for the first time, detects optical photons without destroying them. The technology could eventually offer perfect detection of photons, providing a boost to quantum communication and even biological imaging.

Plenty of commercially available instruments can identify individual light particles, but these instruments absorb the photons and use the energy to produce an audible click or some other signal of detection.

Quantum physicist Stephan Ritter and his colleagues at the Max Planck Institute of Quantum Optics in Garching, Germany, wanted to follow up on a 2004 proposal of a nondestructive method for detecting photons. Instead of capturing photons, this instrument would sense their presence, taking advantage of the eccentric realm of quantum mechanics in which particles can exist in

multiple states and roam in multiple places simultaneously.

Ritter and his team started with a pair of highly reflective mirrors separated by a half-millimeter-wide cavity. Then they placed a single atom of rubidium in the cavity to function as a security guard. They chose rubidium because it can take on two distinct identities, which are determined by the arrangement of its electrons. In one state, it's a 100 percent effective sentry, preventing photons from entering the cavity. In the other, it's a totally useless lookout, allowing photons to enter the cavity.

The technology could eventually offer perfect detection of photons.

When photons get in, they bounce back and forth about 20,000 times before exiting.

The trick was manipulating the rubidium so that it was in what's called

a quantum superposition of these two states, allowing one atom to be an overachiever and a slacker at the same time. Consequently, each incoming photon took multiple paths simultaneously, both slipping into the cavity undetected and being stopped at the door and reflected away. Each time the attentive state of the rubidium turned away a photon, a measurable property of the atom called its phase changed. If the phases of the two states of the rubidium atom differed, the researchers knew that the atom had encountered a photon.

To confirm their results, the researchers placed a conventional detector outside the apparatus to capture photons after their rubidium rendezvous, the team reports November 14 in *Science*.

"It's a very cool experiment," says Alan Migdall, who leads the quantum optics group at the National Institute of Standards and Technology in Gaithersburg, Md. But he warns that identifying photons without destroying them does not mean that the outgoing photon is the same as it was prior to detection. "You've pulled some information out of it, so you do wind up affecting it," he says. Ritter says he expects the photons' properties are largely unchanged, but he acknowledges that his team needs to perform more measurements to confirm that hypothesis.

Ritter notes that no photon detector is perfect, and his team's is no exception: It failed to detect a quarter of incoming photons, and it absorbed a third of them. But he says the power of the technique is that, for many applications of single-photon detectors, each detector wouldn't have to be perfect. Ritter envisions a nested arrangement of improved detectors that, as long as they did not absorb photons, would almost guarantee that every photon was counted. Ultimately, that could benefit fields such as medicine and molecular biology, in which scientists require precise imaging of objects in low-light environments. ■

close to injection sites at the Texas oil field, where a company had been pumping in large volumes of gas since 2004. Eighteen of the quakes were larger than magnitude 3, which is big enough to produce low rumbles.

Before the 2006 quakes, the area had been rumble free since 1983, when a petroleum company halted water injections that triggered earthquakes from 1975 to 1982.

Despite the link to quakes, Frohlich says the idea of storing greenhouse gases underground shouldn't necessarily be dumped. "This doesn't mean it's hugely dangerous," he says. "Like a lot

of science, it raises questions."

The researchers note that oil fields to the north and south of the study site also underwent gas injections but did not experience quakes.

"The really puzzling question is why some places and not others," says Emily Brodsky, a seismologist at the University of California, Santa Cruz. Brodsky and Frohlich agree that scientists need more research to understand which combinations of geological conditions and engineering techniques set off earthquakes. Part of the difficulty, Brodsky adds, is that energy companies often keep private data on injection sites.

"As seismologists," she says, "we're being asked to answer these questions but not always given the data to answer them." ■

"It's inconceivable that the injection wells weren't contributing to these earthquakes."

CLIFF FROHLICH

BODY & BRAIN

Newborns' weak immunity has upside

Immune suppression in infants lets beneficial microbes in

BY NATHAN SEPPA

The seeming failure of newborns to muster a robust defense against infections is a trade-off that delivers long-term benefits, a new study suggests. In infants, the body's immune army stands down for a month or two and then gears up. This gap may allow beneficial bacteria to populate an infant's intestines, researchers working with mice report November 6 in *Nature*.

Neonates' lackluster immunity may be "a normal developmental feature," says biochemist Sidney Morris Jr. of the University of Pittsburgh School of Medicine, who wasn't involved in the study.

The human body houses billions of helpful microbes, called commensal bacteria, which digest nutrients and provide other services, says study coauthor Sing Sing Way, an infectious disease pediatrician at Cincinnati Children's Hospital Medical Center. "They occupy a niche that prevents more-pathogenic bacteria

from occupying the intestines," he says.

In newborn humans and mice, these microbes need to get ensconced in the intestines without the immune system spotting them and calling in the troops.

Way's team found that an immature form of red blood cell is instrumental in toning down immune reactions against microbes in neonatal mice. These still-developing cells, which have a protein on their surface called CD71, also show up in abundance in the umbilical cord blood of human babies, the team showed. In mice, the cells appear to orchestrate immune suppression by making an enzyme called arginase-2, which in turn sends "stop" signals to inflammatory immune cells.

In a series of experiments, the scientists found many more CD71 cells in 6-day-old neonatal mice than in adult mice, resulting in lower levels of inflammatory proteins in the neonates. That left the young mice hospitable to newly arriving microbes. When the scientists depleted the animals' CD71 cells, a

vigorous immune defense ensued against the microbes.

Immune tolerance toward microbes wore off in the mice over three weeks — a period that corresponds to one to two months in humans, Way estimates. At 21 days, the mice's CD71 cell numbers equaled those of 8-week-old adult mice, contributing little to immune suppression.

"This is great. It's a beautiful piece of work," says Mike McCune, an infectious disease physician at the University of California, San Francisco. Doctors might someday be able to adjust immune suppression in newborns as needed to welcome more commensal bacteria or fend off pathogens that pose risks.

Newborn immunity involves more than just CD71 cells; breast milk plays a big role by delivering protective antibodies as it tones down the baby's own defenses. But in general, the new immune suppression findings suggest an evolutionary trade-off with big returns. Infections are common in newborns, Way says, "and maybe 1 or 2 percent of newborns get seriously infected. But 100 percent need to be colonized with commensal bacteria." ■

GENES & CELLS

Immune system has daily rhythm

Mice with jet lag have boosted supply of inflammatory cells

BY MEGHAN ROSEN

Jet lag goofs up more than just sleep schedules: Tinkering with the body's clock confuses the immune system too.

In mice, a type of immune cell linked to inflammation depends on daily cycles of light and dark, researchers report in the Nov. 8 *Science*. The finding could help explain the connection between inflammatory diseases and chronic clock disruptions, such as those experienced by frequent fliers and night shift workers.

"This has implications for all of us," says Lora Hooper, an immunologist at

the University of Texas Southwestern Medical Center in Dallas. "None of us go to sleep when the sun sets or get up when the sun rises." Soaking up artificial light when it's dark outside might predispose people to inflammatory disorders, she says.

Humans, mice and virtually all other animals keep time with circadian clocks, internal timekeepers that sync up with the sun. Researchers have tied people's clocks to sleep patterns, metabolism and mood (*SN*: 4/10/10, p. 22).

Hooper's team examined mice genetically engineered to lack a protein linked to both the circadian clock and to inflammatory bowel disease. The researchers noticed that the animals had inflamed intestines, speckled with more than the usual number of T_H17 cells, a type

of immune cell. These cells are usually beneficial, Hooper says. They help wipe out bacterial and fungal infections at body surfaces such as the skin and the

lining of the lungs. But too many T_H17 cells can trigger inflammation.

In the study, T_H17 cells also piled up in normal mice's intestines when researchers gave the animals jet lag by offsetting the animals' light cycle by six hours. Compared with mice on regular schedules, jet-lagged mice were

more susceptible to inflammation triggered by a dose of chemicals.

Beyond T_H17 cells, the immune system may have other players that march to the rhythm of a daily drum, says immunologist Dan Littman of New York University Langone Medical Center. ■

Soaking up artificial light when it's dark outside might predispose people to inflammatory disorders.

LIFE & EVOLUTION

Stab in the head marks sea slug sex

Hermaphrodite uses thin organ for injections near the eyes

BY SUSAN MILIUS

A newly discovered sea slug adds a special something to mating: simultaneous forehead piercing.

Found on Australia's Great Barrier Reef, the new species of hermaphroditic sea slug has the double set of penile organs typical of *Siphopteron* slugs. Yet the new slugs deploy them in a novel way, says marine behavioral ecologist Rolanda Lange of Monash University in Clayton, Australia.

When the as-yet-unnamed slugs mate, one organ delivers the sperm to the female opening on another slug's body. Seconds after partners position their structures for simultaneous sperm transfer, the slugs each insert a second organ, a needlelike stylet. Each slug plunges it like a syringe into the area around the other's eyes, Lange and her

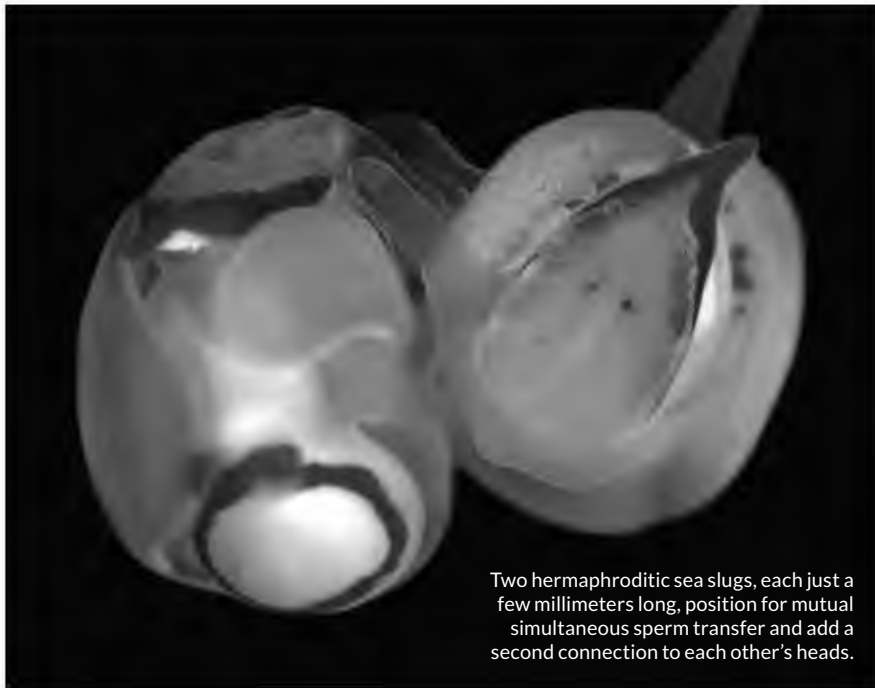
colleagues report November 13 in the *Proceedings of the Royal Society B*.

The stylet organs, throbbing in slow pulses, stay inserted for most of the 40 minutes or so of sperm transfer.

In the matings that Lange observed, all slugs stabbed their partners in the head, rather than a different body zone or a mix of targets as related slugs do. This head strike drives the stylet into the region of the slug's central nervous system, and the slow pulses pump

compounds from one slug into the other.

Just what the slug (for now called *Siphopteron* species 1) gains by such injections isn't clear yet. There are many other species of animal that slip their mating partner manipulative compounds. These biochemicals make the partner invest extravagantly in egg production, for example, make the partner slow to accept the next mate or simply reduce the chances that sperm will get digested for nutrition instead of used for babies.



Two hermaphroditic sea slugs, each just a few millimeters long, position for mutual simultaneous sperm transfer and add a second connection to each other's heads.

BODY & BRAIN

Prion mutation yields diarrheal disease

Rare ailment starts in adulthood, attacking gut before brain

BY NATHAN SEPPA

A newly discovered prion disease damages parts of the body far from the brain. This curious version of these misfolded proteins that are infamous for causing brain-wasting diseases attacks the peripheral nervous system, causing chronic diarrhea and other problems beginning in adulthood.

Researchers report in the Nov. 14 *New England Journal of Medicine* that 11 of 27 people spanning five generations in one family inherited a mutation in the gene that codes for prion proteins, resulting in slow-developing, lethal disease.

People with the genetic defect did develop thinking and memory prob-

lems, but not until their 40s or 50s. Average age at death was 57 for the family members with the disease.

The research stands as a solid addition to the prion literature, says Jan Stöhr, a biochemist at the University of California, San Francisco. "They really did their homework, with all the tests they ran," he says.

Prions are normal proteins, but nobody knows their function. The proteins damage tissues once they become misfolded.

In the new study, the researchers identified the genetic mutation responsible for the diarrhea-causing abnormal

Just why the disease hits the intestines years before the brain is a mystery.

prion. They also examined six of the 11 affected family members and described the unique way the disease develops. The gradual onset follows accumulations of amyloid deposits: clumps of fibrous, insoluble protein. Unlike amyloid in Alzheimer's or other neurodegenerative diseases, the clumps in the new disease show up throughout the body and ultimately compromise various organs' functions.

The newfound aberrant prion also differs from some other known rogue prions at the cell level because it isn't tethered to cell membranes. "It's free floating in

the blood," says study coauthor Simon Mead, a neurologist at University College London.

He suspects that this characteristic might contribute to the protein's tendency to aggregate widely, forming

Partner manipulation “seems to be part and parcel of the mating ritual in many, if not most, hermaphroditic animals,” says evolutionary biologist Menno Schilthuizen of Leiden University in the Netherlands. In July in *PLOS ONE*, he and his colleagues described an *Everettia* snail from Borneo with an unusual love dart, which is a chemical-coated spike that delivers manipulative compounds in snail mating. Unlike other snails that fire love darts into each other during sperm transfer, the *Everettia* snail has evolved darts with hollow internal channels that release fluids through holes like hypodermic needles.

Snail love darts don’t strike a consistent target region as the *Siphopteron* species 1’s stylet does. The new paper focuses on the consistent forehead targeting, but what Schilthuizen finds more intriguing is the paper’s observation that species 1 and four other *Siphopteron* slugs differ considerably in injection sites.

“Copulatory injection itself is widespread,” he says, but “its manner varies as much as all other things sexual.” ■

amyloids and damaging a variety of tissues.

The chronic diarrhea that patients endure may arise from damage to the autonomic nervous system, a part of the peripheral nervous system that extends away from the brain and spinal column. The autonomic network runs processes such as moving food through the gut. Just why the disease hits the intestines years before the brain is a mystery. “Maybe it’s easier to compromise certain gastrointestinal circuits,” Stöhr surmises.

Although this prion disease lacks a cure and is probably rare, Mead says, knowing about it might help to diagnose other people whose diarrhea or other gastrointestinal ailments defy a clear explanation.

While some human misfolded prions are transmissible to mice, tests showed this one is not. ■

BODY & BRAIN

Pregnant mom’s stress alters baby

Microbial shifts in mother mice affected pups’ brains

BY LAURA SANDERS

SAN DIEGO – When stress during pregnancy disrupts a growing baby’s brain, bacteria may be to blame. Microbes take part in an elaborate chain reaction, a new study finds: First, stress changes the populations of bacteria dwelling in a pregnant mouse’s vagina; those changes then affect which bacteria colonize a newborn pup’s gut; and the altered gut bacteria change the newborn’s brain.

The research, presented at the annual Society for Neuroscience meeting, may help explain how a stressful environment early in life can make a person more susceptible to disorders such as autism or schizophrenia. The finding also highlights the still mysterious ways that bacteria living in bodies can influence the brain.

Neuroscientist Cory Burghy of the University of Wisconsin–Madison finds the work promising. “I am excited to take a look at how these systems interact in humans.”

In mice, stress during pregnancy dramatically shifts the mix of bacteria that dwell in the vagina, Christopher Howerton of the University of Pennsylvania in Philadelphia reported November 11. The odor of foxes, loud noise, physical restraints and other stressful situations during pregnancy changed the composition of a mouse’s vaginal bacteria, he and his colleagues found.

After the stress, the population of helpful *Lactobacillus* bacteria decreased. And because newborn mouse pups populate their guts with bacteria from their mother’s birth canal, mice born to moms with lower levels of *Lactobacillus* in the vagina had lower

levels of *Lactobacillus* in their guts soon after birth.

Those lower levels seem to influence the brain, Howerton reported. Genes in a brain region called the hypothalamus behaved differently in mice with low levels of *Lactobacillus* in their guts.

The bacteria-brain connection makes sense, said neuroscientist Jane Foster of McMaster University in Hamilton, Ontario. Other studies have shown that stress can influence bacteria in human bodies, she said, and in turn these bacteria influence how a person’s body

The results may help explain how stress early in life can make a person vulnerable to psychiatric disorders later.

and brain respond to stress. “It is exciting that neuroscientists are starting to pay attention to this important area of research,” Foster said.

It’s not clear how the bacteria in newborn mice’s guts influence gene activity in the brain, but the researchers have some hints: Levels of some key chemicals important for brain development were different in mice born to stressed mothers, the researchers found, an effect that could come from altered nutrient absorption in the gut.

Another possibility is that stress changes the mix of bacteria in the vagina by shifting the levels of immune cells, allowing more dangerous bacteria to slip in and ultimately enter the baby, edging out the friendly *Lactobacillus*, Howerton said.

The results may help explain how stress early in life can make a person vulnerable to psychiatric disorders later, said study coauthor Tracy Bale of the University of Pennsylvania. “Every neuropsychiatric disorder, without exception, is influenced by stress,” she said. Figuring out how stress becomes dangerous might ultimately help scientists prevent its ill effects.

So far, the work has been in mice, but Bale and her colleagues plan to study the effects of stress on bacteria in pregnant women and their newborn babies. ■

HUMANS & SOCIETY

Human ancestors threw spears at prey

Homo sapiens wasn't first species to hurl weapons from a distance

BY BRUCE BOWER

Stone points unearthed in East Africa served as the business ends of the earliest known throwing spears, which human ancestors used to hunt prey around 279,000 years ago.

Hand-cast spears, consisting of sharpened obsidian tips attached to long, presumably wooden handles, allowed ancient members of the human evolutionary family to hunt animals from a distance and avoid dangerous confrontations with prey, say archaeologist Yonatan Sahle of the University of California, Berkeley and colleagues.

Although some researchers have regarded this type of sophisticated tool-making as exclusive to *Homo sapiens*, discoveries at Ethiopia's Gademotta site put throwing spears in the hands of humankind's immediate ancestors, the scientists conclude November 13 in

PLOS ONE. "It seems that cognitive capacity did not change much once *Homo sapiens* emerged around 200,000 years ago," Sahle says.

The finds counter the long-standing idea that spear points attached to shafts didn't appear until after 100,000 years ago, remarks archaeologist John Shea of Stony Brook University in New York. "Gademotta toolmakers probably belonged to *Homo heidelbergensis*, out of which the human species evolved in eastern Africa," Shea says. No hominid fossils have been recovered at Gademotta.

Stone points dating to roughly 500,000 years ago at a South African site are thought to have been tips of spears that were thrust into prey at close range, not thrown from a distance (*SN: 12/15/12, p. 5*).

Unlike the South African discoveries, 12 of 141 Gademotta stone points possibly



Damage on the edge of a stone point dating to between 279,000 and 260,000 years ago indicates that the point was part of a spear thrown at animals. The red area is a stain applied by scientists.

used as weapons display microscopic edge damage suggestive of throwing. The markings resemble those produced in previous experiments on stone-tipped spears shot into a side of beef at speeds typical of heaving weapons from a distance.

Microscopic lines near the bottoms of the Gademotta finds were created by strapping or otherwise attaching the spear points to shafts, Sahle suggests.

Seven of the stone points lay just below a volcanic ash layer dating to 279,000 years ago. The rest date to between 279,000 and 105,000 years ago.

Gademotta overlooked a set of now-dry lakes. Creatures such as hippos and antelope may have been targeted with the spears, Sahle speculates. ■

HUMANS & SOCIETY

Bigger numbers spur invention

Tool innovations take off as more people share ideas

BY BRUCE BOWER

Language, computers and other novelties of human cultures are primarily the products of living in large groups, a new study suggests.

Technological advances and the accumulation of other know-how get a jump start as populations expand, say evolutionary biologist Maxime Derex of the University of Montpellier 2 in France and his colleagues. Their laboratory experiments, reported November 13 in *Nature*, indicate that improvements in tool design occur more frequently as group size grows.

The importance of brute numbers for social learning helps to explain why the

human species, which originated around 200,000 years ago, displayed a rapid burst of cave painting and other complex cultural practices around 45,000 years ago, a time of population expansion, Derex proposes.

And because Neandertals generally lived in smaller groups than ancient people did, greater numbers rather than intellectual superiority gave Stone Age people the upper hand in tool-making, proposes anthropologist Joseph Henrich of the University of British Columbia in Vancouver, who was not involved in the new study. "It's better to be social than smart," Henrich says.

In the new investigation, 366 male college students watched a video demonstrating how to draw an arrowhead or a fishing net. Then they spent 15 trials of a computer game drawing one of the tools. The computer calculated how much food each tool design would yield in the game's virtual world.

Participants were randomly assigned

to groups of two, four, eight or 16. After each trial, players viewed the food scores of others in their group and spent 40 seconds studying the step-by-step procedure to build any one of their teammates' designs.

The two largest groups did best at generating at least one accurately constructed arrowhead and fishing net in the experiment's last three trials. Tool quality gradually increased with group size.

Larger groups were more successful because participants in these groups had an increased probability of seeing and copying occasional changes in tool construction that improved the tool's ability to nab food, the researchers say.

But the benefits of increasing group size may have a limit, at least in this lab game. Performance in eight- and 16-person groups differed little, perhaps because extra information in the largest groups was as distracting as it was helpful, suggests Peter Richerson of the University of California, Davis. ■

LIFE & EVOLUTION

Penguin dispersal timed

Ancestors of the world's formally attired flightless birds may have left the South Pole around 12 million years ago to escape a cold spell. The finding, which researchers report November 13 in *Biology Letters*, clarifies penguins' history. In the most comprehensive study to date, David Lambert of Australia's Griffith University and colleagues analyzed penguin fossils and the sequences of five genes from all living penguin groups. The results suggest that penguins' common ancestor appeared in Antarctica around 20 million years ago. The researchers also found that the major groups of living penguins began branching off between 16 million and 11 million years ago. The timing overlaps with a climate shift around 12 million years ago that cooled Antarctica. The icier temperatures may have spurred the migration and evolution of some penguin species, the researchers suggest. — *Beth Mole*

BODY & BRAIN

Peanut allergy eliminated by bone marrow transplant

In a rare medical twofer, a child with leukemia who underwent a bone marrow transplant emerged free of not only his cancer but his peanut allergy. The child was diagnosed with the allergy at 15 months, said Steven Weiss, an allergist in Syosset, N.Y. At age 4, the boy developed leukemia. At age 10, he underwent a bone marrow transplant, which kills off a patient's bone marrow and the cancerous cells and then replaces them with a donor's marrow. The boy's donor had no known allergy. A year later, the boy's immune system had recovered and tests revealed no peanut allergy. Weiss' collaborator Yong Luo, an allergist in Great Neck, N.Y., said allergies have transferred from a marrow donor to a patient but have rarely been eradicated this way in a marrow recipient. Food allergies are abnormal immune reactions to a food protein. Weiss and Luo hypothesize that the mechanism underlying this aberrant immunity might lie in the early stages of immune cell development in the marrow.



Luo reported the findings in Baltimore November 10 at a meeting of the American College of Allergy, Asthma & Immunology. — *Nathan Seppa*

MATTER & ENERGY

Storage of quantum information breaks room-temperature record

In a significant advance toward quantum computing, physicists have stored snippets of quantum information at room temperature for more than 1,000 times as long as any other experiment. Quantum information comes in units called qubits, which can be in one of two states or, thanks to quantum weirdness, both states at once. This combined state lasts longest at temperatures near absolute zero. Scientists have struggled to make qubits that can survive room temperature, a necessity for future quantum computers. A team led by Mike Thewalt of Canada's Simon Fraser University embedded ultracold phosphorus atoms in an extremely pure silicon matrix. The atoms' nuclei have two possible states: spin up and spin down. The researchers warmed the atoms to room temperature, put their nuclei into a state combining spin up and spin down and measured the time the nuclei took to return to one of the pure spin states. The team reports in the Nov. 15 *Science* that the wait took 39 minutes, smashing the previous two-second record. — *Gabriel Popkin*

Single-atom storage upgraded

Individual atoms can store information for minutes at a time, researchers report

in the Nov. 14 *Nature*. That's more than a billion times as long as previous single-atom experiments. Computer hard drives store data using magnetized cells that each consist of up to a million atoms; the direction of the atoms' collective magnetization determines whether the cell holds a 1 or 0. Scientists would love to coax individual atoms to store information. But single atoms are unpredictable: They continually exchange electrons with their surroundings, causing their magnetization to vary. Wulf Wulfsberg of Germany's Karlsruhe Institute of Technology and colleagues set out to minimize atoms' interaction. They placed atoms of holmium on a platinum surface. Surveying the atoms one by one with a microscope, the team found that the holmium atoms got wedged between platinum atoms, making it difficult for holmium to gain or lose electrons. The holmium atoms had consistent magnetic strength and direction for an average of 10 minutes, besting the previous record of 200 billionths of a second. — *Andrew Grant*

EARTH & ENVIRONMENT

Volcanic activity in Antarctica may contribute to sea level rise

Quivers in West Antarctica have the hallmarks of volcanoes under the ice, researchers report November 17 in *Nature Geoscience*. Volcanic activity in the continent's crust could hasten the flow of the region's ice sheet to the ocean, scientists say. Using 37 seismic stations, Amanda Lough of Washington University in St. Louis and colleagues recorded hundreds of rumbles on the frozen continent in 2010 and 2011. The quakes' frequencies and depths, 25 to 40 kilometers below the ice, are similar to those recorded under active volcanoes in other parts of the world. Though it's unclear whether the quakes signal an impending eruption, the authors say that lava is not likely to burst through the continent's thick ice. But the churning of molten rock could melt the ice's underside and accelerate the flow of the West Antarctic ice sheet, which is already shrinking from warming ocean waters. — *Beth Mole*



Lumos Labs is amassing an enormous amount of cognitive performance data by tracking its customers' performance on the company's brain-training games. Mining the data may produce new ways of spotting early stages of diseases such as Alzheimer's or even more fundamental insights into how the brain works.

Giant brain-training dataset attracts scientists

By Laura Sanders

If you own a television, a computer or a smartphone, you may have seen ads for Lumosity, the brain-training regimen that promises to sharpen your wits and improve your life. Take the bait, and you'll first create a profile that includes your age, how much sleep you get, the time of day you're most productive and other minutiae about your life and habits. After this digital debriefing, you can settle in and start playing games designed to train simple cognitive skills like arithmetic, concentration and short-term recall.

The 50 million people signed up for Lumosity presumably have done so because they want to improve their brains, and these games promise an easy, fun way to do that. The program also offers metrics, allowing users to chart their progress over weeks, months and years. Written in these personal digital ledgers are clues that might help people optimize their performance. With careful recordkeeping, for example, you might discover that you hit peak brainpower after precisely

one-and-a-half cups of medium roast coffee at 10:34 a.m. on Tuesdays.

But you're not the only one who has access to this information. With each click, your performance data will fly by Internet into the eager hands of scientists at Lumos Labs, the San Francisco company that created Lumosity. There, your every response will be deposited into the largest collection of brain data in the world, joining billions of other digital chits generated by users around the globe. At the most recent tally, users have spent over 38 million hours playing more than a billion rounds of Lumosity games.

Giant datasets like this one, created as a by-product of people paying money to learn about and improve themselves, will revolutionize research in human health and behavior, some scientists believe. Lumos Labs researchers hope that their brain-training data in particular could reveal deep truths about how the human mind works.

They believe that they have a nimble, custom-

izable and cheap way to discover things about the brain that would otherwise take huge amounts of money and many years to unearth with standard lab-based studies. Other researchers have also taken note, and some have gotten permission to use Lumosity data in their own research. Some of these researchers are hunting for subtle signatures of Alzheimer's in the data. Others are investigating more fundamental mysteries with cross-cultural studies of how the brain builds emotions and how memory works.

Data collected outside the confines of a pristine, sterile lab can be grubby, lacking the safeguards and quality control that traditional studies impose. And giant datasets can be unwieldy and opaque, burying true results under a mountain of irrelevant information. But even with these flaws, the promise is as big as the datasets themselves, says Anett Gyurak of Stanford University, who has just started studying Lumosity data. "It's an incredible opportunity scientifically," she says.

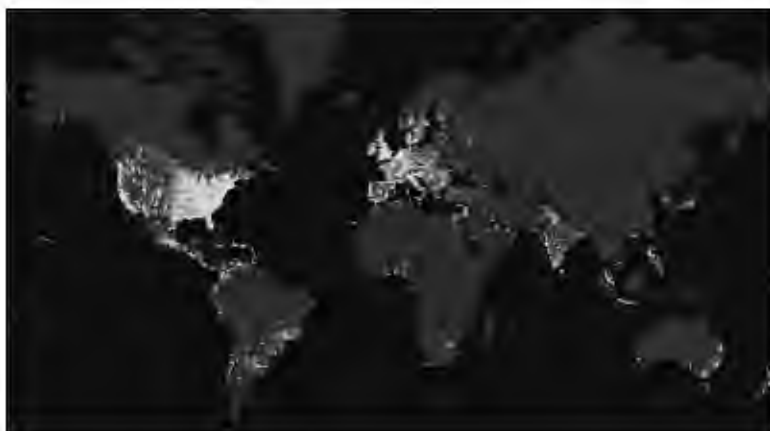
Thinking big

Lumos Labs cofounder Michael Scanlon and his collaborators didn't start their company with the intention of giving scientists access to massive amounts of free digital brain data. The founders' idea was that people can improve their thinking and memory skills by playing online games. Scientists are still working to demonstrate whether brain training actually does that (*SN*: 6/15/13, p. 12). But the by-product of their business endeavor, the Lumosity dataset, is an unexpected research windfall. "I didn't know that we would amass this much data," says Scanlon, who trained in neuroscience at Stanford before going into business.

The first hint that Lumosity might provide an easy means to collect massive amounts of useful brain data came in 2006, when Scanlon and colleagues designed some prototype games for testing. A small test group of about 30 people played some games online and provided feedback and scores. After it was over, Scanlon realized that he had collected the testing data in a fraction of the time it would have taken to bring those people into a lab. "And this wouldn't get any harder if there were 2,000 people instead," Scanlon says.

Or 50 million people. With almost no extra work, the database can grow and grow.

Lumosity user data are primarily used internally by Lumos Labs scientists to refine the company's product. But outside users can also get their hands on the data by submitting a proposal to the Human Cognition Project, Lumos Labs' academic



Global sample A map of locations associated with users' IP addresses (yellow) shows the global extent of Lumos Labs' customer base. Drawn from users in 160 countries, the company's dataset could test whether observations made in small lab experiments extend across cultures and demographic groups.

outreach arm. So far, most of these research projects have focused on whether the games can help people at risk for brain problems, such as certain cancer survivors, young people with psychotic symptoms and people who have suffered a stroke. But some projects focus not on the product's potential benefits, but on what the data have to say about the brain.

P. Murali Doraiswamy, a neuroscientist at Duke University, was one of the first scientists to see the potential in Lumosity's dataset. He teamed up with Lumos Labs scientists to study the effects of sleep, alcohol and age on performance in three categories: working memory, spatial memory and quick arithmetic. For each task, Doraiswamy and colleagues analyzed the performance of over 120,000 people who had also reported how much sleep they get and how much alcohol they drink.

In line with an earlier study of about 5,000 white-collar civil service workers in London that did not use Lumosity data, performance on all three tasks peaked in people who sleep about seven hours a night, the team reported June 20 in *Frontiers in Human Neuroscience*. And performance was best among people who have one to two drinks a day.

These results don't mean that good sleep and moderate alcohol make you smarter. Lots of other associations — like the fact that casual drinkers might have richer social lives than both teetotalers

Wide net A recent study using the Lumos Labs dataset had a far bigger and broader sample compared with a similar lab-based study of sleep and memory. But those expansive data lacked the richness of the lab study's.

SOURCE: D. STERNBERG ET AL./FRONTIERS IN HUMAN NEUROSCIENCE 2013; N. WEE ET AL./SLEEP 2013

Lumosity	Clinical study
Number of subjects: 161,717 65,095 male, 96,622 female	Number of subjects: 19 12 male, 7 female
Average age: 37.97	Average age: 21.6
Location: Worldwide	Location: Singapore
Data: Self-reported sleep duration	Data: Sleep monitoring

These results may come from a game, but they are far from frivolous.

and heavy drinkers — might be causing the effect. But the scientists hope these findings will inspire others to dive into the data to sort some of those things out. In future studies, Doraiswamy plans to measure people's Lumosity performance before and after surgery to see whether he can spot cognitive decline after anesthesia.

Michael Weiner, an Alzheimer's researcher at the University of California, San Francisco, has just begun combing through Lumosity data to look for subtle signs of Alzheimer's. He and his colleagues plan on following people's game performance over time, looking for signs of cognitive decline that might serve as harbingers of approaching Alzheimer's. If the team is successful and game performance does serve as a marker of decline, then the games could be used diagnostically. "You could imagine your doctor might say 'Four times a year, you should go to this website and play these games,' and we'll be using this to determine how your brain is functioning," Weiner says.

Large, cheap datasets may ultimately change the way Alzheimer's research is done, he says. Right now, the problem isn't a lack of ideas. The problem is that there's no money to test them. "It's tens of millions of dollars for one clinical trial," Weiner says. Lumosity's data aren't collected as carefully as they would be in a clinical trial. "It's not the same pristine quality," he says. "But the beauty is there's so much of it. And it's free."

It's free, and it comes from everywhere. Users span the globe, residing in 160 countries at the last tally. In contrast, the typical neuroscience study conducted in a lab enrolls a handful of local college students. Such an international community might reveal regional brain quirks among people who live in different states or countries.

Preliminary results from Bradley Voytek of the University of California, San Diego suggest that

people who live in countries with high rates of traffic fatalities are more distractible, as measured by a particular Lumosity game that requires people to tune out distracting birds. "We have no idea what the underlying cause is," he says. "We don't know if it's education or nutrition or whatever. But we find that more people per capita are likely to die in fatal car accidents if people in their state or country are more distractible. And it's measured by this really simple game."

These results may come from a game, but they are far from frivolous. Road laws could be changed in states or countries at risk in a way that strengthens safety measures. And it's possible that distractibility can be trained away: First-person shooter games improve players' ability to focus on visual information, Voytek says.

Global data also allow scientists to test whether some of neuroscience's deepest-held theories about how the brain works are truly universal. Though researchers generally assume that lab findings apply to all brains everywhere, studies of cognitive traits typically use people in relatively rich, industrialized countries as subjects. So it's possible that universal truths about the brain aren't so universal after all.

"In theory, we're trying to find global general principles. How do people behave?" Voytek says. "But we're basing these global inferences on a very biased group of people."

For example, research has shown that people tend to have similar limits to working memory, the ability to hold a certain number of things in mind simultaneously. With the Lumosity dataset, Voytek plans to look for geographical differences in those limits.

Of course, datasets this large come with challenges. While the dataset spans the globe and boasts impressive numbers, it comes with its own selection biases. "The people who come to our site are people interested in cognitive training," says Lumos Labs research scientist Daniel Sternberg. People not interested in brain training and people with less money to burn aren't well represented in the dataset.

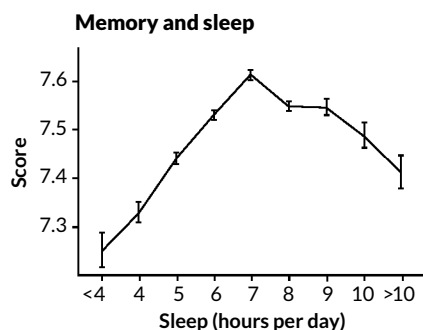
Doraiswamy counters that all studies succumb to this problem. Lab studies also tend to enroll relatively well-off people who are interested in neuroscience, he says. "There's always been a selection bias in research," he says.

For the Lumosity tests, the experimental setting is far from controlled. A

M. ATAROD

Drinking and sleeping People who report drinking one or two alcoholic beverages daily and getting around seven hours of sleep nightly performed best on a Lumosity game that measures spatial memory, a recent study of more than 160,000 users reveals.

SOURCE: D. STERNBERG ET AL./FRONTIERS IN HUMAN NEUROSCIENCE 2013



person could be playing the game on the noisy train or after an all-nighter. The Lumosity subscriber's 8-year-old sister could be taking a turn. The data are inherently messy. But because the dataset is so big, much of this noise averages out, Doraiswamy says.

Dream to reality

The Lumosity dataset is just starting to find its voice, but in some ways, that voice lacks depth. The only thing Lumosity knows is what people enter on a screen. There's no brain scanning, no genetic information, no face-to-face assessment.

Incorporating brain scans and genetic testing into datasets with millions of participants remains a far-off dream. But a few efforts have managed to assemble more extensive collections with thousands of people that are already proving useful.

A company called Brain Resource has collected cognitive questionnaires and tests, EEG results, multiple types of brain scans and genomic data on about 5,000 people. The National Institutes of Health is also funding a similar dataset that will be available to researchers and currently has a huge range of data on 1,500 subjects. "It's one of the richest, most detailed datasets that's available," says Bob Bilder, a UCLA researcher who is leading the NIH-funded effort.

Brain Resource is collaborating with scientists to figure out which people with depression will respond best to which antidepressants. "That is huge," says Alvaro Fernandez, CEO of the neuroscience analytics company SharpBrains in San Francisco. "Right now, we're wasting billions of dollars on medications that people don't respond to, and the process is trial and error." The hope is that some reliable combination of the 165 traits they test, such as certain kinds of brain activity and memory function, could reveal who needs which drugs. In July, Brain Resource submitted a proposal to the U.S. Food and Drug Administration for a proprietary 30-minute cognitive test of memory, attention and emotion that can predict which of three common antidepressants would be most effective. The company is working on a similar tool to predict responses to drugs that treat attention-deficit/hyperactivity disorder.

These approaches still rely on people coming into the lab, but the march of ever-advancing technology might change even that. The Australian neuroengineering company Emotiv has

designed a cheap headset that can unobtrusively and accurately record brain waves as people go about their business. The company says its goal is to democratize brain research by putting brain tools in the hands of the people. On September 16, Emotiv wrapped up a Kickstarter campaign that raised over a million dollars to design a better EEG machine. "The technology is not only escaping the lab," Fernandez says, "it's already way out there in the world. People are devouring these things."

Emotiv's headset performed comparably to lab-quality EEGs in a head-to-head comparison, scientists published in February in *PeerJ*. The result raises the possibility that the device and others like it might be able to identify brain signatures of people with disorders such as ADHD or schizophrenia.

The ideal situation is one in which multiple lines of evidence are all combined, offering a holistic view of a person's health, Doraiswamy and others say. Merging genetic data, cognitive performance, medication and health histories, daily activity logs and symptoms for millions of people would lead to an amazingly rich health resource.

"If all 30 million people with Alzheimer's in the world were on a database, I could instantly give you statistics," Doraiswamy says. "Are rates of Alzheimer's increasing or decreasing? What is the rate of depression? What are the medications that people are reporting as most helpful? Least helpful? How many people are available this month to sign up for a research study?"

We are not there yet, but Doraiswamy's vision could be made real. We already live in a world where much of what we do is tracked, charted and analyzed. Our digital lives reveal where we shop, who we talk to, what songs we like and how we invest. As new biometric apps emerge that can measure the heart's electrical rhythms, analyze sleep patterns and parse a person's genetic code, their data could be merged with databases like the one at Lumos Labs to create unimaginably powerful tools for discovery. ■

Explore more

- Human Cognition Project: hcp.lumosity.com
- D. Sternberg *et al.* "The largest human cognitive performance dataset reveals insights into the effects of lifestyle factors and aging." *Frontiers in Human Neuroscience*. June 20, 2013.



Personal EEG monitors (shown) are now available commercially, giving people the ability to record their own brain data.



One Lumosity game tests multitasking by requiring players to pivot between two distinct tasks: determining whether a number is even or odd and whether a letter is a consonant or a vowel.



Another Lumosity game requires players to quickly report which way the center bird faces while ignoring distracting flanking birds.



Heal Thy Neighbor

Mental health services recruit locals to help residents of poor and war-torn countries

By Bruce Bower

Nearly all the women of Mohmandara, a village in eastern Afghanistan near the Pakistan border, met at a local health clinic one day in 2005. Mental health workers at the clinic, run by a Dutch international aid organization, had heard village women talking to each other about “feelings of sadness” and “worrying too much.” The women eagerly accepted an invitation to talk it over at the clinic.

The village women described being beaten and harassed by their husbands, who were spurred on by their mothers and sisters. Families were imploding. Everyone in the group agreed that unemployment and poverty, in a land hounded by warfare, lay behind the surge of domestic violence.

With the help of a local woman trained by the aid organization, HealthNet TPO, the wives formulated a plan of action over several meetings. Close relatives were recruited to act as mediators between wives and their husbands’ families. The women practiced settling and defusing disputes at home. With help from another aid group, the wives raised money to buy chickens so they could sell eggs for added income.

Family life didn’t suddenly become tranquil. But for the first time, the village women felt hopeful that they could do something to reverse a deteriorating situation.

This emergency intervention was no isolated incident. Promising innovations in mental health care are popping up in some of the world’s most impoverished and devastated places.

From Afghanistan to India, Uganda and beyond, a “take it to the people” model of psychotherapy is emerging. Stepping outside their traditional role as treatment providers, psychiatrists and psychologists train and supervise laypeople to deliver brief forms of group or individual psychotherapy. Early research suggests that inexpensive, nonprofessional therapists can effectively treat depression, anxiety and trauma-related problems, the most common mental ailments in the world today.

Scientists are beginning to explore the impact of war and lifelong hardships on mental health. One early discovery: Being accepted back into a family and community greatly alleviates suffering among former child soldiers, a fact that supports a growing international focus on social as well as psychological interventions.

“Humanitarian crises offer opportunities to build effective mental health care systems in developing nations,” says psychiatrist Vikram Patel of Sangath Centre, a nonprofit health organization in Goa, India. Massive emergencies focus attention and outside assistance on the psychological needs of survivors. Politicians presiding over distraught populations suddenly become receptive to redoing mental health systems.

In Afghanistan, that opportunity came after the fall of the Taliban government in 2001. With the central Asian nation’s

A psychosocial worker in Burundi in 2005 assists a boy with epilepsy and his father with mental health and epilepsy treatment.

PETER VENTIVOGL/HEALTHNET TPO

entire health system in tatters, the new government contracted with aid agencies to set up mental health training and counseling centers in several regions. After 2004, the Ministry of Public Health worked with aid agencies and the World Health Organization to integrate those services and provide mental health training to physicians, nurses, midwives and people with no health care background. In 2010, Afghanistan's government launched a national strategy for expanding mental health care.

In developing nations, where WHO estimates that there is an average of one psychiatrist serving anywhere from 200,000 to 1 million people, those who need mental health care usually don't get it. Researchers say that a key to extending mental health care's reach is to deploy available psychiatrists and psychologists as trainers and supervisors of nonprofessional counselors — including villagers in some of the world's poorest and most violent regions. Lay counselors do the nitty-gritty work of coordinating each patient's care, as well as providing brief group and individual psychotherapy to those who need and want it.

A 2013 WHO report titled "Building Back Better" describes how, in the aftermath of wars and natural disasters, ambitious mental health reforms have been instituted and are starting to make a difference in Afghanistan and 10 other countries and territories since 2000.

Many people living in war zones and impoverished communities suffer from a mix of mild to moderate depression, anxiety disorders and stress reactions to traumatic experiences, says Mark van Ommeren, a psychiatric epidemiologist at WHO in Geneva. Talk therapies adapted to specific cultures and lasting about six sessions show promise in easing these problems, he asserts. Psychiatric drugs can be used if needed with brief psychotherapy.

"There is an enormous need for mental health services, and it can't be met without training generalists who treat people in their own communities," van Ommeren says.

No humiliating labels

One of the most ambitious efforts to build and study a mental health care system that puts nonprofessionals on the front lines is happening in Goa, a small state on India's west coast. This project, directed by Patel, encourages everyone from health counselors to psychiatrists to refer to patients' emotional problems with local terms, not psychiatric labels viewed as humiliating and shameful in Indian cultures. "We never say 'depression' or 'mental illness' when treating patients," Patel explains. "That vocabulary isn't culturally appropriate."

Patients in Goa often speak of anxiety problems as "tension" or "worry," and describe depression as "going into hiding." Health counselors use those terms to inquire further about

Speak no evil Lay counselors avoid using mental health terms that would embarrass or stigmatize people seeking help. SOURCE: V. PATEL, ABHIJIT NADKARNI AND B. KOHRT

Clinical term	Common term (translated)	Location
Anxiety	Tension, worry	Goa, India
Depression	Going into hiding	Goa, India
	Thinking too much	Zimbabwe
Trauma	Heart and mind distress	Nepal
	Stress	Goa, India

a person's daily problems and to develop a treatment plan.

Patel led an investigation called MANAS that evaluated how effectively nonprofessionals treated poor and working-class people with common mental disorders. MANAS is an acronym for "project to promote mental health" in India's Konkani language. Treatment trials ran from April 2007 to

September 2009 at 12 public primary health care centers and in 12 private medical practices.

Researchers tracked nearly 2,800 adult patients with depression and other common mental ailments, most for one year. Roughly half of these individuals received care coordinated by locally recruited health counselors who completed two months of training organized by MANAS researchers.

Health counselors provided information about symptoms and treatment, referrals to social welfare agencies, advice about breathing exercises and other strategies to lessen anxiety, and six to 12 sessions of interpersonal psychotherapy adapted for India. Developed in the United States, interpersonal psychotherapy addresses ways to strengthen relationships and counteract triggers of depression in a person's life.

Primary care physicians prescribed medications for depression or anxiety to about one-third of psychotherapy patients, in consultation with a psychiatrist who also treated especially troubled individuals referred by health counselors.

Another group of patients in the trials received mental health care from primary care physicians who could consult treatment manuals prepared by the MANAS team.

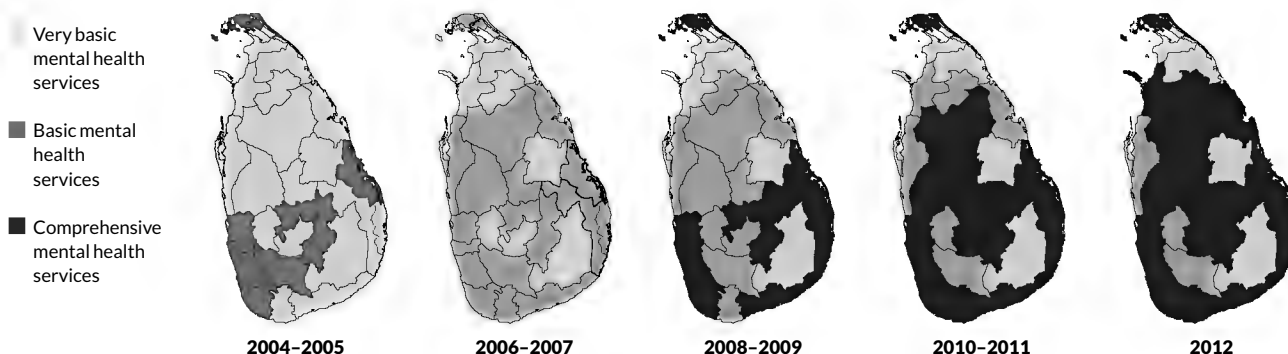
Interpersonal psychotherapy and other interventions delivered by health counselors substantially relieved patients' depression and improved their work and home lives for up to one year after treatment started, Patel and his colleagues report in the April *British Journal of Psychiatry*. Physician-led care produced more modest benefits.

In Uganda and Brazil, Patel's group notes, recent trials produced similar gains for depressed patients who



Two midwives, left, interview an Afghan villager as part of their mental health training in a program run by an international aid organization.

Expanding help Sri Lanka maps portray the growth of mental health facilities and services from 2004, the year of a devastating tsunami, to 2012. What began as scattered psychiatric hospitals and outreach clinics grew to a network of inpatient and outpatient facilities covering much of the island nation. SOURCE: SRI LANKA MINISTRY OF HEALTH, WHO



received brief psychotherapy and other services from trained nonprofessionals.

Even with the cost of training and hiring health counselors for MANAS, mental health treatment cost less when led by nonprofessionals than by physicians, at least in public facilities, Patel and other researchers reported in a 2012 *Bulletin of the World Health Organization*.

Efforts are underway to expand MANAS throughout India.

Group relief

In a rural part of the Democratic Republic of the Congo that has been plagued by warfare for nearly 20 years, women have had no access to professional help to deal with the emotional aftereffects of rape and other conflict-related ordeals. Clinicians and researchers are beginning to bring brief psychotherapy to these beleaguered people and others like them who live far from cities, hospitals or safe havens.

Group psychotherapy delivered by trained nonprofessionals shows particular promise in such settings.

Psychiatric epidemiologist Judith Bass of Johns Hopkins University led a project that successfully treated trauma-related problems among Congolese women (*SN Online*: 6/6/13). Bass' team trained Congolese women who had experience in assisting rape survivors to provide either group therapy or individual support to 405 traumatized women in 15 villages. Most of those getting help had been raped by government or rebel soldiers.

Groups of six to eight women received up to 12 sessions of cognitive processing therapy, a treatment for post-traumatic stress disorder developed in the United States more than 20 years ago. Lay counselors, supervised weekly by a Congolese social worker trained in the therapy, focused on getting rape survivors to stop blaming themselves for their misfortune and to formulate strategies for moving on with their lives. Women receiving individual support mainly received medical and social welfare referrals.

Six months after treatment, the proportion of women with probable PTSD had dropped from 60 percent to 9 percent in the cognitive processing therapy group, with similar declines

for depression and anxiety. About half of the women who had received individual support still struggled with PTSD symptoms, depression and anxiety six months later.

"We saw women who once felt stigmatized reengage with their families and communities after receiving cognitive processing therapy," Bass says.

Evidence of group therapy's benefit comes from northern Uganda as well, where civil war raged from 1987 to 2008. Men and women who attended two to five monthly group counseling sessions displayed faster reductions in PTSD symptoms and depression over the next three months than individuals who declined counseling sessions. Group meetings helped participants—including 10 individuals infected with HIV—function better at work and at home, psychiatrist Etheldreda Nakimuli-Mpungu of Makerere University in Kampala, Uganda, and her colleagues reported in the October *Journal of Affective Disorders*.

In that study, counselors and social workers at four privately funded trauma clinics in northern Uganda conducted group sessions with 69 volunteers already receiving antidepressants or other medications for mental ailments. Ugandans participating in those groups shared trauma stories, learned relaxation techniques and devised new ways to cope with their lives.

Impacts of poverty vs. war

In developing countries, war isn't the only threat to mental health. One long-term investigation indicates that extreme poverty and social discrimination inflict a brand of emotional harm apart from that caused by living through violent conflicts.

In the South Asian nation of Nepal, many people have endured episodes of depression set off not by wartime experiences but by lifelong poverty and social mistreatment, says Brandon Kohrt, a medical anthropologist and psychiatrist at Duke University School of Medicine. In contrast, among poor Nepalese villagers, violent experiences during a prolonged civil war—but not economic hardships and other stresses unrelated to the war—triggered anxiety problems, including intrusive memories of life-threatening events and other

Tough times for U.S. psychotherapy

Talk therapy is declining in the land of the free and the home of the medicated. Psychologist Myrna Weissman of Columbia University sees a bitter irony in that trend.

"Psychotherapy is becoming less accessible in the United States as it is being enthusiastically embraced in developing countries hurt by HIV, natural disasters, wars or political strife," says Weissman, codeveloper of a brief form of psychotherapy called interpersonal therapy.

From 1998 to 2007, the proportion of patients in U.S. outpatient mental health clinics receiving psychotherapy alone fell from 15.9 percent to 10.5 percent, while the proportion prescribed medication alone rose from 44.1 percent to 57.4 percent. Primary care physicians, who treat most cases of depression and other common mental ailments, increasingly prescribe psychoactive medications as well.

Yet a growing number of studies show that interpersonal therapy, cognitive behavioral therapy and a few other talk therapies — most lasting 20 sessions or fewer — help patients and their families more over the long run than medication does, with far fewer side effects. Surveys consistently find that depressed patients and their families would prefer psychotherapy over medication.

In an editorial in the Sept. 29 *New York Times*, psychologist

Brandon Gaudiano of Alpert Medical School of Brown University argued that professional psychotherapy organizations must launch aggressive educational campaigns to burnish talk therapy's tarnished image.

Real progress in reducing mental disorders will require dramatic changes in how interventions are delivered, Gaudiano and Brown University psychologist Ivan Miller wrote in the November *Clinical Psychology Review*. That shift in distribution includes forming mental health care teams with psychotherapists supervising physicians and lay counselors. Efforts to do just that are under way in the United Kingdom and several other Western nations, but not in the United States, says psychiatric epidemiologist Mark van Ommeren of WHO in Geneva.

A network of inexpensive, community-based lay counselors trained in one or more brief psychotherapies, able to refer severe cases to professionals, would be a big step forward for U.S. mental health care, says psychiatrist Vikram Patel of Sangath Centre in Goa, India. In this setup, psychotherapy would be provided in schools, community centers and homes, not hospitals and offices.

"Western mental health professionals need to appreciate that, for most people, their mental health and their daily lives are integrally connected," Patel says. "It's not like having a boil on your back." —Bruce Bower

cardinal signs of PTSD, Kohrt and his colleagues reported in the October 2012 *British Journal of Psychiatry*.

"War has been assumed to increase rates of depression and anxiety alike, but that wasn't the case when we tracked mental health before and after Nepal's conflict," Kohrt says.

Cognitive behavioral therapy and a few other types of brief psychotherapy work well at easing mild to moderate depression and anxiety in Western nations. Kohrt studied whether culturally customized versions of these treatments could do the same in countries where depression and destitution go hand in hand.

He and his colleagues asked nearly 300 Nepalese villagers to complete assessments of depression and anxiety in 2000, about a year before a war began between government and rebel forces. Villagers responded to the same surveys again in 2007, about a year after violence ended.

The proportion of depressed villagers rose from 31 percent to 41 percent, a trend largely explained by the aging of this population, Kohrt says. Depression most frequently affected the poorest villagers, who belonged to one of Nepal's lowest social castes. His team estimates that being in a low caste — and thus facing perpetual social exile by neighbors from higher castes — inflamed depression among Nepalese villagers as

much as the most severe war traumas triggered PTSD and other anxiety disorders.

Anxiety ailments increased from 26 percent to 48 percent, a trend that exceeded what could be attributed to aging. Villagers who had witnessed armed groups murder people and experienced other wartime ordeals reported the worst anxiety symptoms. About 14 percent had PTSD.

Some clinicians say that non-Western victims of life-threatening events don't react in ways that neatly fit within U.S. psychiatry's official definition of PTSD. Western psychiatrists focus on individuals' reactions to specific traumas, such as being raped or witnessing a comrade's death during combat. In family- and community-oriented countries emerging from years of civil war, many people are traumatized by the loss of traditional social ties and rampant mistrust among survivors, including relatives, some

researchers contend. Community-wide programs that repair the social fabric may have more potential in these settings than individual or group psychotherapy.

Open arms

The power of social forces to mend or aggravate war's emotional wounds resonates loudly among former child soldiers.

60
percent

PTSD rate in a group of Congolese women before therapy

9
percent

PTSD rate among those women after as many as 12 sessions of group therapy

Tens of thousands of children under age 18 currently serve in government forces or armed opposition groups.

Family and community acceptance of young ex-combatants does wonders for their mental health, even without psychotherapy or other interventions, says psychiatric epidemiologist Theresa Betancourt of Harvard School of Public Health.

Her team studied 243 former child soldiers, most in their late teens, in the African nation of Sierra Leone. These young people typically got abducted into a rebel army during childhood and spent several years with their captors acting as spies, porters, fighters and — mainly among 73 girls in the sample — sex slaves.

From 2004 to 2008, PTSD rates declined from 32 percent to 16 percent, although few youngsters received formal counseling of any kind, Betancourt's group reports in the September *British Journal of Psychiatry*.

Stress symptoms cleared up the most among ex-soldiers who were openly welcomed back into their families and communities. Those who returned home only to experience a parent's death or threats and abuse from community members tended to get worse.

Former child soldiers who faced rejection in their communities also reported escalating loneliness, depression, anxiety, stealing and fighting, the researchers report September 14 in the *Journal of Child Psychology and Psychiatry*.

Kohrt has reported similar findings for former child soldiers in Nepal. His team worked with private aid groups and residents of several villages to find ways to support returning youngsters. Strategies included holding public welcome-back ceremonies and encouraging ex-soldiers to return to school and join sports or drama clubs.

Effective treatments, Kohrt says, need to follow the lead of India's MANAS program and employ language that defuses cultural stigmas about mental ailments.

"With former child soldiers in Nepal, we used 'heart and mind distress' as a general term for bad memories and other trauma symptoms," he says. "That made it easier for them to talk."

Like soldiers anywhere, Kohrt adds, ex-child combatants in Nepal who suffered the worst emotional problems experienced a "double hit" of trauma. Youngsters first got steamrolled by the awfulness of war. Then they were blindsided by rejection and mistreatment upon returning home.

In Nepal, girls who had been abducted into rebel groups suffered the harshest double hit. These kids had been forced to be sex slaves, yet their defilement marked them as unacceptable to families and communities. Girls, far more than boys, suffered from lasting PTSD, Kohrt says. He and his colleagues



Child soldiers were easy to pick out at a rally of Nepal's Maoist rebel army held in 2007, the year after a decade-long civil war ended.

plan to work with aid organizations to help incorporate these girls back into schools and social clubs.

A hard road

Kohrt knows that it's an uphill battle to treat the mental aftereffects of long-term conflicts. But opportunities for revamping psychological care continue to sprout from the rubble of social and natural disasters.

Consider Sri Lanka, a teardrop-shaped island off India's southern coast. The new WHO report outlines how, following a devastating 2004 tsunami, this nation parlayed international aid into a network of community mental health services that collaborate with hospitals and outreach clinics.

As in Afghanistan, locally recruited lay mental health workers in Sri Lanka build trust with families and refer people in need to outreach clinics that have been established in many parts of the country.

Although the tsunami attracted worldwide publicity, Sri Lankans also struggle with the emotional repercussions of a less well-known civil war. More than 100,000 Sri Lankans were killed and many more injured or displaced between 1983 and 2009, according to a report in the January *International Journal of Mental Health Systems*. To deal with both tragedies, Sri Lanka's mental health system needs to go beyond psychotherapy and experiment with community interventions, including organizing public mourning and healing ceremonies and forming women's groups and youth clubs, say psychiatrists Daya Somasundaram of the University of Jaffna in Sri Lanka and Sambasivamoorthy Sivayokan of the University of Adelaide in Australia.

In Libya, the emotional wounds of war are fresher. Heavy fighting in Libya throughout 2011 resulted in an urgent need for mental health care, remarks WHO's van Ommeren. "WHO is now active in a program to build a new, community-based mental health system in Libya," he says.

That effort, coordinated by WHO and Libya's Ministry of Health, is training the nation's small number of psychologists in brief psychotherapy for ex-combatants and their families. Lay counselors will be trained to identify common mental ailments and refer people for psychological care.

Poverty, oppression and warfare will continue to generate a need for neighbor-based therapy and community-strengthening interventions in many parts of the world. Lessons learned in today's zones of conflict and deprivation will likely influence mental health care for years to come. ■

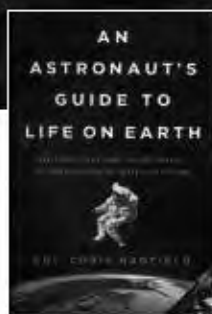
Explore more

■ WHO Mental Health website: bit.ly/X2la7

INTERVIEW

Making the most of zero gravity

Astronaut and author Chris Hadfield discusses life in, and after, space



Legendary astronauts like John Glenn and Neil Armstrong achieved fame through single extraordinary moments. Yet Chris Hadfield (above, on the International Space Station) is arguably the most famous post-Apollo astronaut thanks to his YouTube videos chronicling astronauts' everyday lives. His new book, *An Astronaut's Guide to Life on Earth*, includes what he learned from his time at the Canadian Space Agency. *Science News* talked to Hadfield, who recently retired after a five-month stint on the International Space Station, about a few of the experiences discussed in his book and his thoughts on space science and exploration.

How has the transition back to Earth been going?

It's rude when you get home. Your body has to instantaneously go from the graceful elegance of perpetual weightlessness to the tyranny of gravity. Your balance system is messed up, you're nauseous and you can't walk. It's as if you've just got off this horrible spinning ride coupled with the worst flu you've ever had. You recover from that pretty quickly. But it took about four months before I didn't feel like I had two tubes of lead for legs for running, and I'm still growing bone back across my hips.

What inspired you to address seemingly mundane zero-g activities, such as cutting your nails, in your videos and book?

Over a long time I spoke at thousands of schools, businesses, even the United Nations, and I found that everybody wanted to know: What's it like in space? How do you brush your teeth? How do you go to the bathroom? So I resolved myself that if I get up in space long enough, I'm going to make a quick video and show those things. And those videos, some as simple as what happens when you wring out a cloth in space, just went crazy. So my guess was true: People just have a fundamental curiosity.

You're best known for making a "Space Oddity" music video on the ISS. What were the challenges of rocking out in space?

Playing the guitar is weird. When your hand comes up the neck, the whole guitar takes off sideways because the guitar is actually just floating in front of you. You have to find some

new way to brace the guitar to make it work. The vocals are slightly different too, because without gravity your sinuses never drain. It's sort of like standing on your head forever.

Which of the science experiments on the space station most captivate you?

The space station has about 200 experiments going simultaneously, and astronauts are somewhere between lab technicians and lab rats. One of the best experiments is the Alpha Magnetic Spectrometer, which is gathering subatomic particles and whatever the universe throws at us to try to figure out the universe's composition. We don't know what 95 percent of the universe is. Hopefully, over the next decade, the space station will give us pretty compelling evidence of what the universe is made of.

Based on your extended stay in space, what have you learned about the challenges of a manned mission to Mars?

Mars is a long ways away. It's going to take half a year just to get there and then a half-year to get back. You're going to leave Earth and not get somewhere for a long, long time. The psychological impact is that there's nothing in your window; there's no huge, stimulating, omnipresent view of our planet to look at. Those crews on the way to Mars are going to have a schism with Earth within a week or two, because Earth will become a distant visual memory. Those crews are going to have to become Martians for their own psychological health.

—Andrew Grant

NASA



BOOKSHELF

The Tell

The Little Clues That Reveal Big Truths About Who We Are

Matthew Hertenstein

While most people think they're good at spotting liars, the truth may come as a surprise. The vast majority can detect a lie only 54 percent of the time (barely better than flipping a coin). A tiny percentage, maybe one in 1,000 people, can discern a lie more than 80 percent of the time. These "truth wizards" are exceptionally keen at reading a person's facial expressions and body language, among other clues.

Hertenstein, a psychologist, chronicles research into what such nonverbal cues can reveal about a person. The book's title alludes to a poker player's term for a mannerism that can provide clues about an opponent's cards (*SN: 10/19/13, p. 8*). Research suggests that even brief observations of another person's "tells" can offer keen insights into their personality, on-the-job success and even whether their marriage is likely to survive a rough spot.

Hertenstein makes the case that tells are revealing at all ages and in many spheres

of life. Want to know whether a child is at risk of developing autism? After decades of study, he writes, researchers have identified several tells — behaviors seen briefly but intermittently throughout the first 18 months of life — that can help predict autism. In another example, behavioral scientists observing children in a lab setting for a mere 45 minutes can predict who will grow up to be cautious and anxious rather than outgoing and confident.

Anyone can use tells, not just experts. By watching as little as six seconds of video of a college instructor, students can accurately predict how highly the instructor will be rated at the end of the semester. Even 5-year-old kids can do it: Youngsters in distant lands can typically look at photos of candidates in U.S. elections and pick who the winners will be.

Hertenstein reminds readers that tells — whether used to judge a job applicant, a criminal suspect or a potential mate — are merely clues about a person's personality, not hard evidence. Nevertheless, he argues, awareness of such cues can help people hone powers of observation and assess interactions with others in a more sophisticated and nuanced way.

First impressions of another person can be powerful. But they can be even more insightful if you know what to look for.

— Sid Perkins

Basic Books, \$26.99



Octopus!

Katherine Harmon Courage
Using an engaging blend of cultural and scientific

investigation, the author leaves no stone unturned in this contemplation of all things octopus. She reveals a mercurial creature that has captivated minds (and taste buds) for millennia. *Current*, \$27.95



Buried Glory

Istvan Hargittai
A chemist profiles the struggles of scientists in the Soviet Union,

including Nobel-winning physicist Petr Kapitza and Nobel Peace Prize winner Andrei Sakharov, who helped develop the Soviet hydrogen bomb and later became a peace activist. *Oxford Univ.*, \$35

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SCREENTIME

Best science to see and hear



OXFORD SPARKS: A QUICK LOOK AROUND THE LHC

Every day, hours and hours of audio and video about science are uploaded, downloaded and shared. And now the Science Studio website has stepped in to curate that flood of information. Science Studio bills itself as "a collection of the best science multimedia on the web." A panel of 39 judges, including notable science writers, watched and listened to 120 nominated videos, radio programs, animations and more, whittling down to 31 satisfying science bites from 2012. Selections range from well-known programs such as *Radiolab* on NPR to the best from bloggers and NASA's media pros. There's something for any science buff, whether it's instructions for extracting your own DNA on *NOVA* or an animated view of particles inside the Large Hadron Collider (left) from Oxford University. The project was funded by a grant from the National Association of Science Writers and donations on the crowdfunding website Kickstarter. Nominations for the next edition open January 1. See www.thesciencestudio.org. — Erika Engelhaupt



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Seeing sadness' sunny side

Bruce Bower wrote about the cognitive benefits of a blue mood in "The bright side of sadness" (SN: 11/2/13, p. 18). A negative mood can increase recall, attention to detail and a sense of fairness to others, the article noted.

Bower's story was the most read on the *Science News* website in October, with a spike of more than 94,000 views after being posted on the social news site reddit.com. Reddit reader **DrMasterBlaster**, self-described as a graduate student studying negative emotions, commented that "everyone assumes that negative affect [meaning bad feelings or emotions] is always bad, and that isn't always the case. Additionally, there's this idea that to make a good decision we must be emotionless automatons, which is also not the case. Emotions are just another source of information, so while we shouldn't be ruled by affect, it can and does provide us with important decision-making information."

On the *Science News* website, **stmccrea** commented, "It seems obvious that emotions are part of our survival system. It's high time we stopped viewing any inconvenient emotion as pathological—we need our emotions to make sense of the world."

And finally, one reader hoped to use the story to her advantage. **Maja Ramirez** quoted from Bower's story: "People in sad moods show a greater willingness to work on demanding tasks ... and are more concerned with being fair to others." So, Ramirez e-mailed, "if I nag my husband enough about the undone things on his 'honey-do' list, he should be bothered enough to not only take up his tools and get to work, but to admit I was right all along?" It depends, **Bower** responds. The "down" moods that were beneficial in studies were not full of high-intensity emotions. "Everything hinges on nagging your husband into a sad mood," Bower says. "If you nag him into anger, frustration or a glazed state of inattention, don't expect him to bounce off the couch."

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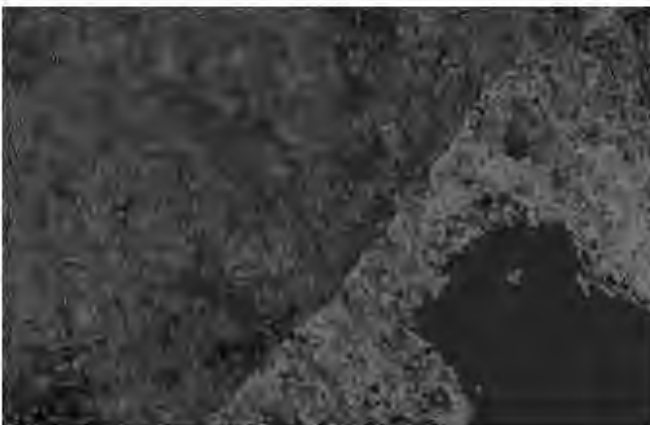
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Online map tracks forest shifts from space

By layering more than 650,000 satellite images onto a Google map, researchers have created a new tool to track forest cover. The online tool, described in the Nov. 15 *Science*, lets users walk through space and time, zooming from single plots to a global view. The big picture isn't so pretty. From 2000 to 2012, logging, fires, storms and other disturbances wiped out 2.3 million square kilometers of forest (red). Still, the maps reveal some bright spots: Brazil has cut back on clearing rainforests. And worldwide, 800,000 square kilometers of new forest have sprung up (blue) in the U.S. Southeast, Russia and elsewhere. Green marks areas unchanged over the period; purple marks areas with both losses and gains. — *Meghan Rosen*



Baltic cyclone In 2011, a cyclone ripped through Finland's forests. As the storm hurtled across the Russian border, winds gouged a gash in the forest more than 160 kilometers long (red). Satellite images reveal the cyclone's path as well as differing logging practices in the countries. In Finland, small-scale logging leaves the land evenly speckled with trees (upper left). In Russia, increased logging has not yet reached the border region, which remains cloaked in green (lower right).



Sumatra rainforest After decades of clear-cutting and burning upland tropical rainforests, loggers and developers in Sumatra have started clearing lowland areas too. The map above highlights the advance of forest destruction into one area of the island's east coast. A color gradient tracks forest losses by year, from yellow in 2000 to red in 2012. Many of these forests are peatland swamps that could release vast stores of carbon after being cleared.

M. HANSEN ET AL./SCIENCE 2013