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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ NOVEMBER 17, 2012

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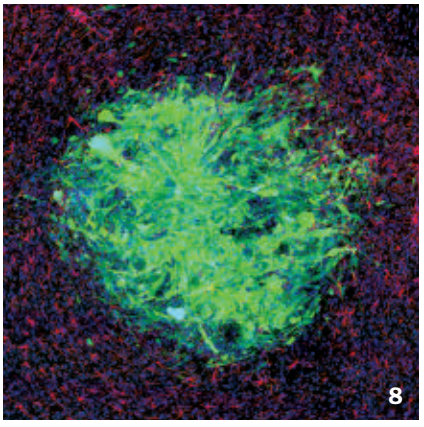

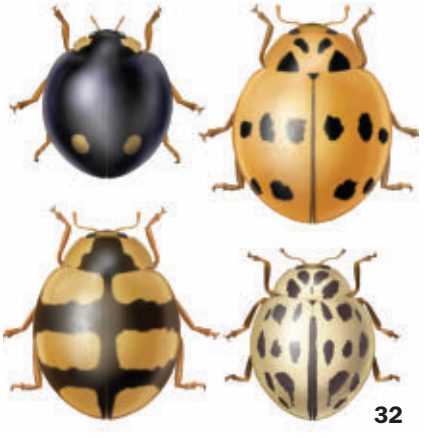

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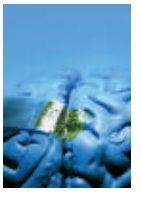

COVER Melding electronics to tissue promises an era of smart medical devices. *J. Rogers/Univ. of Illinois, D.-H. Kim* et al/Nature Materials *2010*

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FROM THE EDITOR

Tracking storms and other human smarts

The first winds of Hurricane Sandy blew into Washington, D.C., just about as predicted. From the *Science News* offices, you could see gusts whipping power lines and shaking trees by midday on October 29. The office was officially closed (as were federal offices in the city), but a skeleton crew of editors and designers were in to make sure this issue didn't fall behind schedule.

Between proofreading pages that day, I checked Sandy's progress. Satellite images revealed a massive white swirl, its tentacles reaching from the Atlantic to the Midwest. Doppler radar showed the wet already soaking the region. Maps based on computer simulations outlined the storm's predicted journey.

Those amazing images show how far meteorologists have come in being able to predict, track and provide early warnings for big storms. We knew Sandy was going to hit and about when it would arrive, even if it wasn't clear exactly how bad it would be. The forecasts may be imperfect, but they still offer an impressive testament to human ingenuity.

Much harder, but perhaps still within the realm of human cleverness, is the effort to understand how global warming influences extreme weather events like hurricanes. On Page 22, senior editor Janet Raloff details some of the first successes in applying what's known as attribution science to weather extremes. Scientists have been able to show that climate change is at least partially to blame for hotter-than-normal summers in the last decades. Recent evidence points to a role for global warming in the 2003 heat wave blamed for some 70,000 deaths in Europe and the devastating 2011 drought in Texas. In contrast, tornadoes (at least 1,625 of which hit the United States in 2011) haven't been linked to climate change (though a lack of data makes it difficult to show one way or the other).

It's not yet clear to what extent changes in hurricane frequency or intensity can be linked to global warming. And for Sandy, it's too soon to know if climate change helped create this perfect storm. Some analyses say a rise in sea-surface temperatures has coincided with a boost in hurricane intensity. And rising sea levels clearly worsen the kind of storm surges seen in New York and New Jersey during Sandy. Luckily, human ingenuity is a force as powerful as any storm. Given time and support, it may even prove a match for climate change. — *Eva Emerson, Acting Editor in Chief*

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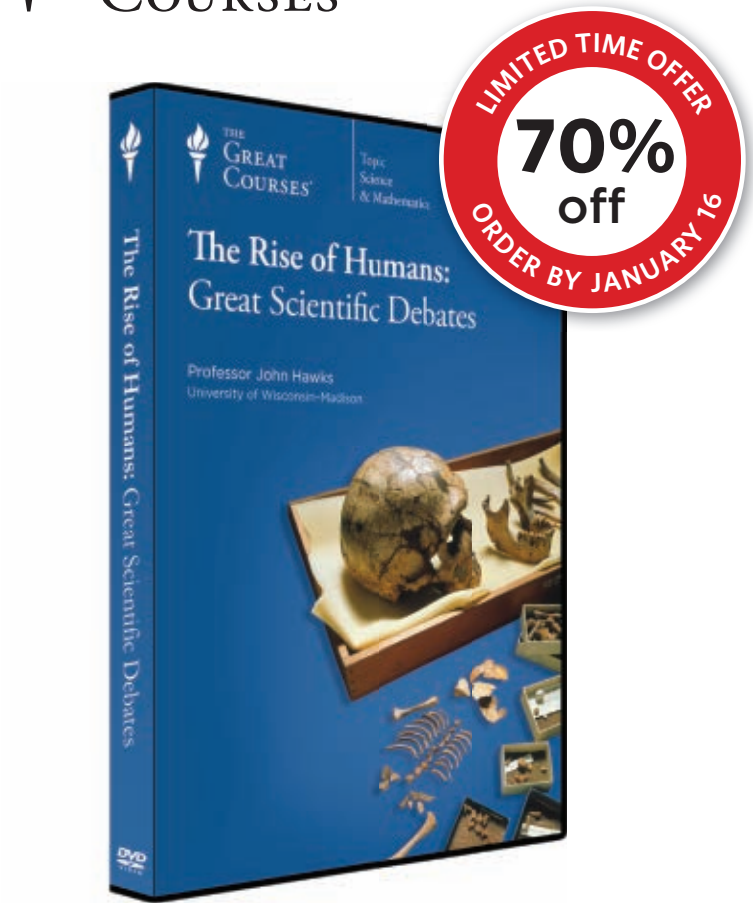

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17. Is Our Neandertal Heritage Important?
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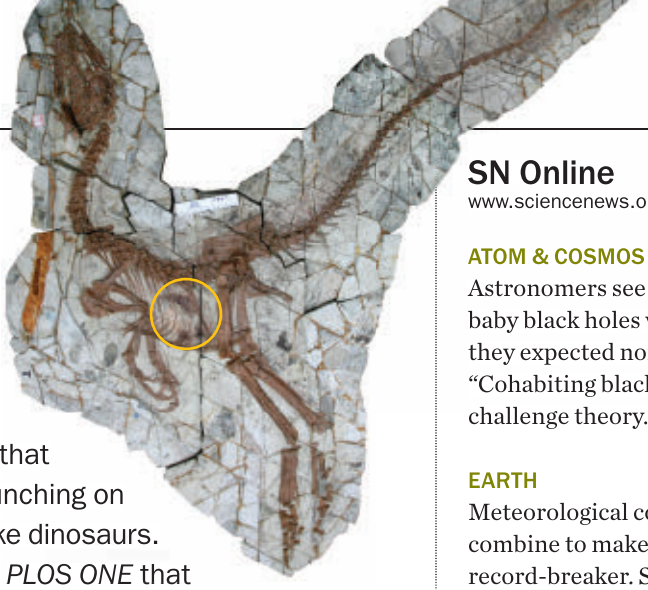
Say What?

Cololite *COH-loh-lite*\ *n.* The fossilized contents of an ancient creature's gut. Cololites from two skeletons found in northeastern China of the fuzzy *T. rex* cousin *Sinocalliopteryx* contain the remains of the dinosaurs' last meals. Feathers, leg bones and other bits (circled, right) indicate that the 8-foot-long *Sinocalliopteryx* had been munching on the early bird *Confuciusornis* and small, birdlike dinosaurs. Paleontologists suggest online August 29 in *PLOS ONE* that *Sinocalliopteryx* would have needed stealth to take down its feathered prey. Like a modern cat, it may have stalked and pounced on birds before its meals took flight. —*Sarah Zielinski*



Science Past | FROM THE ISSUE OF NOVEMBER 17, 1962

COMPUTER MIMICS WEATHER — How and why the world's weather behaves as it does is being attacked by one of the most powerful computers yet built. The U.S. Weather Bureau in Washington, D.C., dedicated a new research laboratory aimed at gaining better understanding of the earth's atmosphere. Mathematical models of the atmosphere up to 20 miles above the surface are tested in the new laboratory on an International Business Machines' STRETCH computer.... The electronic "brain" is expected to simulate day-to-day changes at 10,000 points around the world, analyzing surface weather patterns plus those at nine levels above the surface. Some ten billion computations will be required to model these weather changes during a 24-hour period.

Science Future

November 29–December 2
Documentary films and other forms of storytelling explore the diversity of world cultures during the Margaret Mead Film Festival at the American Museum of Natural History in New York City. More information at bit.ly/SFmeadfest

December 6
Try out creative thinking processes and practice LEGO challenges at the Creativity and the Brain session at the Columbus, Ohio, Center of Science and Industry. See the COSI calendar at bit.ly/SFcosical

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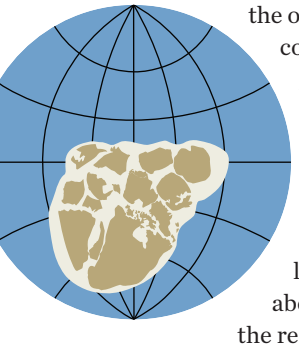
ATOM & COSMOS
Astronomers see two baby black holes where they expected none. See "Cohabiting black holes challenge theory."

EARTH
Meteorological conditions combine to make Sandy a record-breaker. See "Low central pressure among Hurricane Sandy's unusual features."

Warm temperatures in the Antarctic have helped hold down the size of the hole in the ozone layer this fall. Read "Ozone hole at smallest size in decades."

LIFE
Vampire squid are scavengers, not blood-sucking predators. See "Vampire squid no Gordon Gekko."

Introducing | NEW VIEW OF THE ANCIENT GLOBE

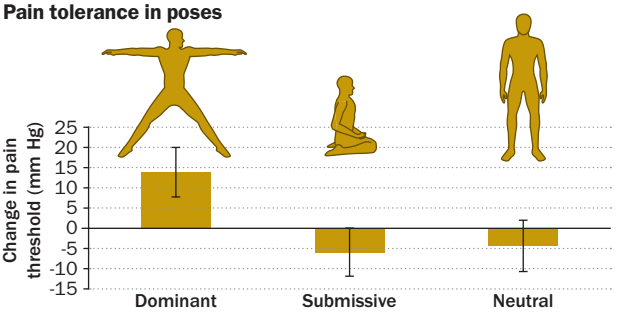


Long before the continental mash-up known as Pangaea, Earth's landmasses had clumped together — and the oldest of these supercontinents is now coming into focus. A Chinese-led team has gathered new paleomagnetic evidence into a map showing the oldest supercontinent (left). The landmass, known as Nuna or Columbia, combined the most ancient pieces of Earth's crust, with Siberia and the Baltics taking a central location. Nuna probably existed between about 1.8 billion and 1.4 billion years ago, the researchers report in the Nov. 1 *Earth and Planetary Science Letters*. —*Alexandra Witze*

Science Stats | PAIN POSTURE

Feeling powerful may help you feel less pain. Volunteers in a pose rated as "dominant" could withstand more pain than those in a neutral or submissive pose — at least in an experiment in which participants indicated when a blood-pressure cuff became painful before and after assuming a position. SOURCE: V. BOHNS *ET AL/J. EXPT. SOC. PSYCH.* 2012

Pain tolerance in poses



CLOCKWISE FROM TOP LEFT: L. XING *ET AL/PLOS ONE* 2012; NOAA-NASA GOES PROJECT; STEPHEN EGTS; S. ZHANG *ET AL/EARTH & PLAN. SCI. LETTERS* 2012

“It’s really a great sample if you’re interested in studying something that has more or less been delivered straight from Mars, uncontaminated, to the Earth.” —CARL AGEE, PAGE 12

In the News

STORY ONE

DNA swap may prevent rare genetic diseases

Cloning-like method would correct mitochondrial flaws

By Tina Hesman Saey

Extracting the nucleus from the egg of a woman who has faulty energy-producing organelles called mitochondria allows researchers to transfer her chromosomal DNA into a donor egg using an extremely fine needle (shown). The method may be used to prevent inherited diseases caused by mutations in the mitochondrial DNA.

A technique that puts one woman’s nuclear DNA into another woman’s donor egg cell may be feasible for correcting inherited diseases caused by faulty cellular power sources. The technique has already produced healthy baby rhesus monkeys, and now it raises the possibility of preventing mitochondrial diseases in human newborns.

Mitochondria, energy-producing organelles inside cells, carry loops of DNA important for the power plants’ function. Mutations of the mitochondrial DNA, which is passed to offspring directly by their mothers, can cause diseases that often affect energy-greedy organs such as the brain, heart, muscles, pancreas and kidneys with varying severity. An estimated 1,000 to 4,000 U.S. babies are born each year with mitochondrial diseases.

Swapping the nucleus, the cellular compartment where chromosomes are housed, from an egg with mutant mitochondria into an egg containing functional power plants could stop those diseases from happening in the first place. Offspring would inherit healthy mitochondria from the egg donor, while the rest of their genetic makeup would come from the mother and father.

Researchers led by Shoukhrat Mitalipov, a reproductive and developmental biologist at Oregon Health & Science University in Beaverton, previously demonstrated that the technique works with rhesus monkeys. Now the team has succeeded in transferring the nuclei of unfertilized human eggs into donor eggs. Zygotes created by fertilizing those eggs produce embryonic stem cells, the team reports online October 24 in *Nature*. Short of actually transplanting the embryos into women to grow into fetuses, stem cell production is the clearest sign that the embryos are normal.

Performing the transfer procedure in the United States for women who carry faulty mitochondria, and implanting resulting embryos in the womb, will require approval of the federal Food and Drug Administration, which oversees clinical trials involving gene therapy.

Although the experimental therapy requires transfer of a nucleus into an egg, as human cloning would, it does not raise the same ethical concerns as human cloning, says Josephine Johnston, a research scholar at the Hastings Center, an organization in Garrison, N.Y., that examines the ethics of biological research. “To me it’s not human cloning,” Johnston says. “It’s not the creation of an individual who is genetically identical to an existing person.”

Not everyone is comfortable with the technique because children would carry DNA from three parents — a set of chromosomes each from the mother and father, and mitochondrial DNA from an egg donor. “Any time reproduction is proposed to take place in a novel way, some people get nervous,” Johnston says. But if the technique is safe, she says, she sees no major ethical concerns barring it from reaching the clinic.

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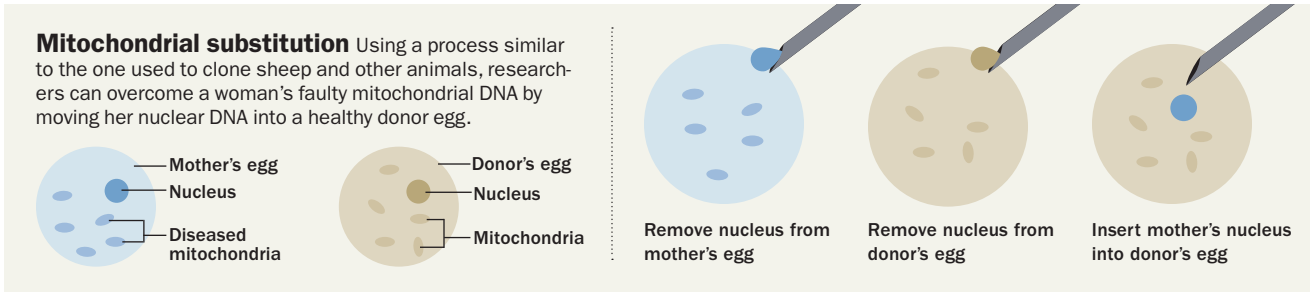

Rhesus monkeys produced using the technique are now healthy 3-year-olds, Mitalipov and his colleagues report. "They are as normal as they can get," he says.

An unexpected finding from the monkey research may aid efforts to freeze human eggs, which may be important if the technique is going to be used to correct mitochondrial defects in people. It is difficult to precisely synchronize women to produce eggs at the same time, and eggs go bad quickly once collected. So Mitalipov and colleagues tested whether the transfer procedure would work with frozen eggs.

The researchers found that frozen intact monkey eggs developed into embryos only 6 percent of the time after fertilization, while more than half of fresh eggs did. Transferring DNA from a fresh egg into a frozen-and-thawed egg produced no viable embryos, but moving DNA from a frozen egg into a fresh one resulted in embryos at a similar rate as when both eggs were fresh.

Scientists have thought that eggs don't freeze well because DNA gets damaged, Mitalipov says. But his results suggest that DNA in the nucleus weathers the frost while something in the rest of the cell is damaged, possibly the mitochondria. The findings indicate that women carrying defective mitochondria may be able to freeze their eggs so that their DNA can be transplanted into fresh donor eggs at a convenient time.

In general, however, human eggs proved trickier to work with than those from monkeys. About half of zygotes created by fertilizing eggs that had undergone the nuclear transfer were abnormal.

That result doesn't surprise Mary Herbert, a reproductive biologist at Newcastle University in England. "The unfertilized egg has the complex task of remaining poised in readiness to halve its DNA content upon sperm entry. Given the biological complexities associated with maintaining this state, we have always held the view that manipulation of the egg at this stage would be rather precarious," she said in a statement on behalf of her research team.

Previously, Herbert and her colleagues had performed a similar technique using fertilized human eggs, extracting and transferring the "pronuclei" — the nuclei from the parents' egg and sperm before the two have fused — into healthy donor eggs. Using fertilized eggs reduces the risk of abnormal fertilization, she says.

The Oregon researchers have tested that method in monkeys without success, Mitalipov says. "Embryos fail early and no pregnancies established," he said of his group's unpublished experiments. The failure may be due to drugs applied to the cells to make the technique work.

But transferring nuclei in unfertilized eggs shows promise, and Mitalipov hopes to win FDA approval for human clinical trials. "The FDA has been slow to respond," he says. "Meanwhile, every year, thousands and thousands of children are born with mitochondrial diseases, so we'd like to hurry up." ■

Back Story | POWER SHORTAGE

Rare, harmful mutations in mitochondrial DNA began coming to light in the 1980s, when scientists first began detailed studies of the mitochondrial genome. The small, circular piece of DNA encodes proteins necessary for energy production. So far, more than 300 dangerous mutations have been discovered.

Though symptoms can vary widely among mitochondrial disorders, they all seem to arise from the same underlying cause: a chronic shortage of energy caused by defects in the body's cellular power-producing machinery. Often, energy-intensive organs such as the heart, brain and muscles are most affected by mutations in mitochondrial DNA. —*Laura Sanders*

Common mitochondrial disease–causing mutations

Affected gene	Major symptoms
MT-ND1	Vision loss, usually in young adulthood
MT-TL1	Stroke-like episodes, seizures, dementia
MT-TK	Muscle twitching and weakness, seizures, movement disorders
MT-RNR1	Deafness
MT-TL1	Deafness, diabetes

SOURCE: L. GREAVES *ET AL/JOURNAL OF PATHOLOGY* 2012

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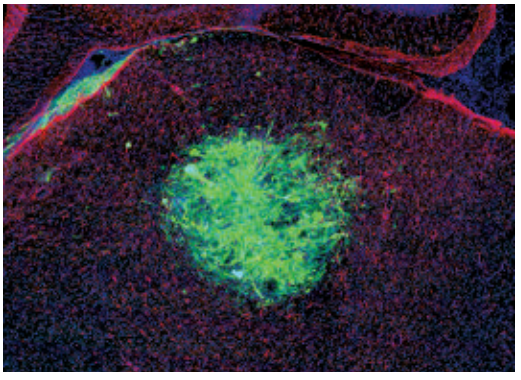
Brain cancer's tenacity explained

DNA damage to adult cells implicated in glioblastoma

By Tina Hesman Saey

New work could help explain why a deadly type of brain cancer recurs easily even after surgery, radiation and chemotherapy have apparently banished it. Fully developed brain cells, not just stem cells, may take on new identities to evade therapy and then come back later, the study suggests.



A glioblastoma (green) grew in a mouse's brain after scientists tweaked two cancer-related genes in brain cells called astrocytes (red).

Just two changes to cancer-related genes in some adult brain cells are enough to spur the genesis of glioblastomas, Inder Verma, a molecular biologist at the Salk Institute for Biological Studies in La Jolla, Calif., and colleagues report online October 18 in *Science*.

The new study touches on a debate about which types of cells can lead to cancer, says Martine Roussel, a molecular biologist at St. Jude Children's Research Hospital in Memphis, Tenn. Some forms of cancer seem to start only when mutations build up in specific cells. Previous studies had indicated that glioblastoma may result when genes within naturally occurring stem cells in the brain are mutated. But the new study indicates that glioblastoma can originate in at least two types of mature brain cells, and that the genes struck by mutations are more important than the type of cell.

Verma's team infected a small number of brain cells in mice with viruses carrying genes that reproduce alterations found in patients with glioblastoma. Each infected brain cell suffered a one-two punch when the virus simultaneously shut down activity of a protein called p53 — which normally stops cells from growing out of control — and activated one of two cancer-promoting proteins.

The double hit caused two types of brain cells known as astrocytes and neurons to revert to a more flexible, stem cell–like state, the researchers found.

Researchers have been reprogramming adult cells to such states in the lab for several years, but the new findings indicate that some types of cancer may result when that sort of reprogramming happens in the body, says Jean-Paul Thiery, a developmental biologist at the National University of Singapore.

That could be ominous for cancer patients and their doctors, because constantly morphing tumor cells may be nearly impossible to get rid of. "If you're chasing one target," Thiery says, "you'll always miss the boat."

Death by magnet for cancer cells

Metal nanoparticles trigger internal suicide machinery

By Rachel Ehrenberg

Evil geniuses, commence drooling. Scientists have figured out how to remotely control a cell's self-destruction. Magnets that guide the behavior of tiny metal beads can be used to flip on a cell's death switch, kick-starting demolition. The approach might one day be used to kill cancer cells or orchestrate other cellular events without drugs or incisions.

In the new work, a bit of protein guides tiny iron-containing nanoparticles to death receptor 4, an aptly named handle on the outside of a cell that acts as a molecular doomsday switch. Exposing the cells to a magnetic field makes the nanoparticles clump together. This clumping pulls together the three molecular prongs that make up the switch, activating it and triggering processes that lead to the cell's demise.

Scientists from Yonsei University in South Korea tried the approach with a dish of colon cancer cells. Within 24 hours, more than half of the cells exposed to the magnetic field were dead, the team reports online October 7 in *Nature Materials*.

"This might be a new way to do really targeted therapeutics," says bioengineer Andrew MacKay of the University of Southern California. Figuring out how to target only particular cells is an ongoing problem, though. Death receptor 4 sits on normal cells too, which can also be destroyed via remote-controlled magnetism. When the researchers tested their approach on developing zebra fish, the tails of the exposed fish developed a kink where cells were killed off.

It's not yet clear whether the magnetic field could be directed with such finesse and specificity that it would kill only tumor cells and not nearby healthy cells. Many cancer cells become resistant and stop responding to the protein that normally hits the death switch; such cells also might not respond to the magnetic nanoparticle version, says Courtney Broaddus, a doctor at the University of California, San Francisco who investigates resistance in cancer cells.

COURTESY OF ERIC BUSHONG

Earth

0.93 percent — Atmospheric abundance of argon

0.0000087 percent — Atmospheric abundance of xenon

Xenon shortage in air explained

Differential capture of noble gases in Earth may be cause

By Alexandra Witze

As detective stories go, the Mystery of the Missing Xenon may not have the catchiest title. But scientists in Germany say they might have cracked this long-standing enigma.

The reason there's less xenon in Earth's atmosphere than expected, the researchers say, is that there was never much xenon dissolved in the planet's depths to begin with. Had there been, it would have made its way over billions of years toward the surface, there to spew into the atmosphere.

"This model is enough to explain the whole xenon deficiency," says Svyatoslav Shcheka, a geochemist at the University of Bayreuth in Germany. He and Hans Keppler, also of Bayreuth, report the finding in the Oct. 25 *Nature*.

Shcheka and Keppler had been studying materials from the lower part of Earth's mantle where intense pressure creates minerals like perovskite, rich in magnesium, silicon and oxygen. In high-pressure lab experiments, perovskite had been behaving unexpectedly, and the team discovered this was because the mineral's crystal structure doesn't always contain an oxygen atom in the space where an oxygen atom could be. Rather, something else fills that space — possibly a noble gas, a class of elements that includes argon, krypton and xenon.

The scientists decided to see if they could dissolve noble gases in perovskite under pressure to find the missing ingredient. They found that argon dissolved easily, to the point that it made up just over 1 percent of the mineral. Krypton dissolved less readily, and xenon dissolved hardly at all — making up only about 0.03 percent of the perovskite. That's probably because xenon atoms are too big to slot easily into the spaces in perovskite left by missing oxygen, Shcheka says.

Billions of years ago, the infant Earth was completely molten, with gases trapped within. As it cooled, the new theory goes, minerals began to crystallize out and trap those gases. Perovskite trapped mostly argon and some krypton, but little xenon, the scientists propose.

Meanwhile, the primordial atmosphere and its xenon got mostly stripped away, perhaps blasted off by radiation or incoming meteors. Once the planet cooled enough, it began to churn internally. Like a pot bubbling on the stove, this churning brought materials from deep within the planet to the surface, where they released their contents into the atmosphere. This journey would have involved perovskite rich in argon and poor in xenon.

Other scientists aren't so sure of this scenario. Chrystèle Sanloup, a geochemist at the University of Edinburgh, has studied other, shallower places in the Earth where xenon might be locked up. She says the new paper can't explain several aspects of xenon geochemistry, including how Mars could also be lacking xenon in its atmosphere when it has very little perovskite in its depths.

Fault still sliding years after quake

Creeping movement underscores seismic danger to Istanbul

By Alexandra Witze

Keeping an eye on geologic faults can be useful even long after they convulse in a great earthquake. By watching a Turkish fault after a deadly 1999 quake, geologists have pieced together a detailed picture of creeping fault movement after a big shake-up.

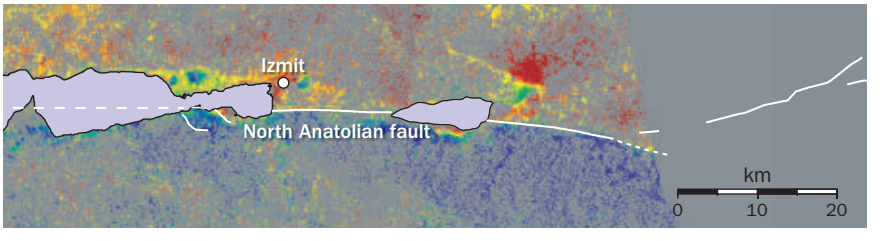
The magnitude 7.4 Izmit quake broke part of the North Anatolian fault, killing more than 17,000 people. In the years since, scientists have found, the two sides of the fault have started to creep past each other again at rates up to about 27 millimeters annually, most likely building up stress to the west near Istanbul.

"There aren't many places in the world where this kind of thing has been observed," says Chris Marone, a geoscientist at Penn State who was not associated with the research.

Ziyadin Çakir, a geologist at Istanbul Technical University, and his colleagues combined satellite measurements of how the ground has shifted with field observations to show what the Izmit part of the fault has been doing. They describe the new work online October 2 in *Geology*.

When one part of the fault ruptures in a quake, it releases stress in that area but transfers some of it to neighboring areas. Close to Istanbul, the fault has not broken in a major quake since 1766. Seismologists consider it ripe for an earthquake of magnitude 7.0 or greater.

Ups and downs After the 1999 earthquake near Izmit, Turkey, the ground began deforming in ways that suggest the fault continues to move slowly, building stress. In this image, based on satellite radar data, red and orange show sinking ground; blue and green, rising ground.



Z. ÇAKIR

Humans

"It may not be that difficult to continue to slow the rate of mortality." —BRIAN KENNEDY

Trust affects kids' patience

Belief in others influences ability to wait for rewards

A young volunteer contemplates a tempting sugary treat during an exercise that tests her willingness to wait for a better reward.

By Bruce Bower

Willpower alone doesn't explain why some children forgo a marshmallow in hand for the prospect of getting two gooey treats later. Kids' beliefs about the reliability of the people around them can dramatically shape willingness to wait for a sweeter payoff, a new study finds.

Expectations about whether it's best to grab goodies before they disappear or trust that bigger returns will come later are as important to delaying gratification as self-control, say psychologist Celeste Kidd of the University of Rochester in New York and her colleagues. Her team's findings appear in a paper published online October 9 in *Cognition*.

Kidd's team modified a procedure, called the marshmallow task, that was first tested in 1972 by psychologist Walter Mischel, now of Columbia University. An experimenter would lead preschoolers to a room where they could eat a marshmallow, cookie or pretzel placed on a table or wait 15 minutes to get two treats. Children lasted an average of about six minutes before munching a treat in hand. When Mischel followed up with the kids years later, he found that the longer kids had managed to wait, the better they did socially and academically as teens.

In the new experiment, Kidd's group tested 28 youngsters, ages 3 to 5, on the marshmallow task. Before testing, the children completed an art project. Half dealt with an unreliable experimenter who failed to deliver on promises to bring back fancy art supplies and cool stickers. The rest had a reliable experimenter who provided art supplies and stickers as promised.

Children who had been disappointed by an experimenter waited for an average of about three minutes before eating the marshmallow, while those who got what was promised lasted 12 minutes. After an unreliable encounter, only one of 14 kids waited the full 15 minutes for the second marshmallow, compared with nine of 14 kids assigned to a reliable experimenter.

Findings consistent with Kidd's study go back 50 years, Mischel says. In 1961, for instance, Mischel reported a preference for immediate rewards among 8- to 9-year-old boys without a father in the home, relative to boys with a mother and a father.

"Kidd's finding makes good sense, but it's not surprising," Mischel says.

Modern living vastly extends life

Widespread human longevity a 20th century phenomenon

By Rachel Ehrenberg

Despite what the fashion magazines tell you, 40 isn't the new 30. Seventy is.

A new study finds that humans live so much longer today compared with the rest of human history that the probability of dying at 72 is similar to the death odds our ancestors likely faced at 30.

This uptick in longevity is quite recent—occurring in the last century and a half—which suggests it has little to do with genes, starvation diets or antiaging miracle drugs. Rather, it is likely due to eliminating environmental dangers faced by *Homo sapiens* of old, an evolutionary anthropologist and his colleagues argue online October 15 in the *Proceedings of the National Academy of Sciences*.

Oskar Burger of the Max Planck Institute for Demographic Research in Rostock, Germany, and colleagues analyzed previously gathered data on chimpanzees, modern hunter-gatherer societies in parts of Africa and South America, and people in the Human Mortality Database for Japan, Sweden and France.

The data reveal a steady drop in the probability of dying young that begins just before 1900 for the French and Swedes. The mortality numbers for hunter-gatherers remain closer to those of wild chimpanzees than to these Westernized societies. However, when the researchers looked at hunter-gatherer groups receiving some Western medicine and occasional food, the mortality in those groups dropped to numbers comparable to pre-1900 Sweden and France.

"It may not be that difficult to continue to slow the rate of mortality," says molecular biologist Brian Kennedy of the Buck Institute for Research on Aging in Novato, Calif. "I still believe very strongly that it's going to be possible to manipulate healthy life span."

J. ADAM FENSTER/UNIV. OF ROCHESTER

Life

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Finding Ms. Right is right eye's job

Finches court like fools if they use only the left visual field

By Susan Milius

A patch over a male Gouldian finch's right eye works like beer goggles. If limited to using his left eye when checking out possible mates, he risks making stupid choices.

Gouldian finches have caps of black, red or yellow feathers on their heads. In nature, the birds prefer to mate with partners of the same cap color. Yet black-headed males rendered temporarily left-eyed by a tiny removable eye patch flirted as readily with red-heads as with black-heads, says cognitive ecologist Jennifer Templeton of Knox College in Galesburg, Ill. That's not smart because daughters typically fail to survive when Gouldian finches mate outside their cap color.

Also the male himself becomes less attractive, Templeton says. When the bird's right eye was covered, he sang less during courtship. Some patch-wearing males didn't make up their minds at all, Templeton says, but "just hopped around randomly."

Gouldian finches usually choose mates who share their cap color. Covering a male's right eye makes him more likely to court females of different cap colors.

Moving the eye patch to uncover the right eye and block the left, however, restored male Gouldian finches to their senses. Males then spent more time perching near and flirting with same-cap-color females, Templeton and her colleagues report online October 3 in *Biology Letters*.

A bird's right eye connects to the left hemisphere of its brain, and the left eye to the right hemisphere. Unlike mammals, birds don't have a high-speed connection between hemispheres. (A bird's neural structure does allow information to transfer, but it takes hours.) So detecting an eye bias in birds gives clues to what goes on in their brains.

The importance of the right eye/left brain for flirting among these finches and other birds might at first seem to contradict another long-standing finding of mating bias, says Lesley Rogers of the University of New England in Armidale, Australia: It's the right hemisphere that controls copulation. "In order to view a mate it is necessary to suppress copulation, at least initially."

Early arthropod had fancy brain

Fossil preserves three-part central nervous system

By Erin Wayman

Rusty red stains on the head of a fossilized segmented creature found in China are a paleontological record breaker: They are the remains of the oldest arthropod brain ever found. The 520-million-year-old imprint of the critter's brain indicates that complex nervous systems evolved fairly early in animal evolution in a common ancestor of insects, centipedes and crustaceans.

The roughly 7-centimeter-long specimen represents *Fuxianhuia protensa*, which lived during the Cambrian period, before modern arthropod lineages evolved. The fossil shows *F. protensa* had a three-part brain that sat in front of the animal's gut. That's the same setup seen today in insects, crabs, lobsters and many other arthropods, researchers report in the Oct. 11 *Nature*.

"It suggests that the organization we see in the modern [arthropod] brains is very ancient," says coauthor Nicholas Strausfeld, a neuroscientist at the University of Arizona.

Scientists had thought that early arthropods had simpler brains like those of tiny freshwater crustaceans called branchiopods. The branchiopod brain consists of two connected parts with a third mass of tissue sitting behind the stomach. Sometime after the branchiopod lineage split from other arthropods, scientists had assumed, the nervous tissue behind the gut migrated and connected with the other parts of the brain.

"With this complex Cambrian brain, we have to rethink our current interpretation," says Steffen Harzsch of the University of Greifswald in Germany. The ancestors of branchiopods probably had a more complicated brain originally and later did some evolutionary backpedaling, he says.

The ancient arthropod *Fuxianhuia protensa* (nearly intact specimen in main photo) had a surprisingly complex three-part brain (inset).

FROM TOP: SARAH R. PRYKE/MACQUARIE UNIV.; MAIN: X. MA/NATURAL HISTORY MUSEUM. INSET: N. STRAUSFELD/UNIV. OF ARIZONA

Atom & Cosmos

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Blobs from sun hit and bounce

Massive balls of gas show superelastic behavior

By Tanya Lewis

A pair of giant gassy plumes ejected by the sun four years ago ricocheted off each other like bouncy balls, a new study shows, changing solar physicists' ideas about how these eruptions of charged particles and magnetic fields can behave.

Captured on camera by NASA's Solar Terrestrial Relations Observatory probes in November 2008, the two balls of charged gas smashed together and rebounded with more energy of motion than they had before the collision, scientists report online October 7 in *Nature Physics*. The phenomenon is known as a superelastic collision.

"Such a phenomenon is not frequently observed in nature," says study coauthor Yuming Wang, a physicist at the University of Science and Technology of China in Hefei. Scientists have observed it on the scale of small particles, but not with massive balls of charged gas.

The collision observed by Wang and his team boosted the total energy of motion in the ejections by 6.6 percent. The researchers suggest that magnetic and heat energy in the charged gas balls was converted to kinetic energy as they were expanding.

These solar eruptions, known as coronal mass ejections, possess an amount of energy on the order of a billion atomic bombs, Wang says. Understanding how the eruptions interact is crucial for predicting space weather, which affects communications satellites and spacecraft.

In the case of these solar eruptions, scientists want to know when the fallout will hit Earth. "Collisions are more likely to cause intense events on Earth than individual eruptions. It's important to pinpoint where they are and reduce damage," says atmospheric and space scientist Noé Lugaz of the University of New Hampshire.

Scientists probe fresh meteorite

Rocks found in Morocco hold clues to Mars' atmosphere

By Tanya Lewis

A meteorite that streaked to Earth in a blazing fireball over the Moroccan desert is one of the freshest samples of Mars' surface and atmosphere that scientists have ever found.

Local residents recovered fragments of the Tissint meteorite, one of just five from the Red Planet that have been seen during descent, after it landed on July 18, 2011. The meteorite formed from Martian lava worn down by weathering, possibly by liquid water, researchers report online October 11 in *Science*. Then, about 700,000 years ago, an asteroid impacted the Red Planet and blasted a piece of that rock into space, on an ultimate collision course with Earth.

The 1.1-kilogram fragment described in *Science* resembles a meteorite found in Antarctica in 1980 that was the first to show strong evidence of its Martian origin. But unlike other Martian meteorites that have sat on Earth's surface many years before being discovered, Tissint hasn't had much time to be altered by terrestrial influences.

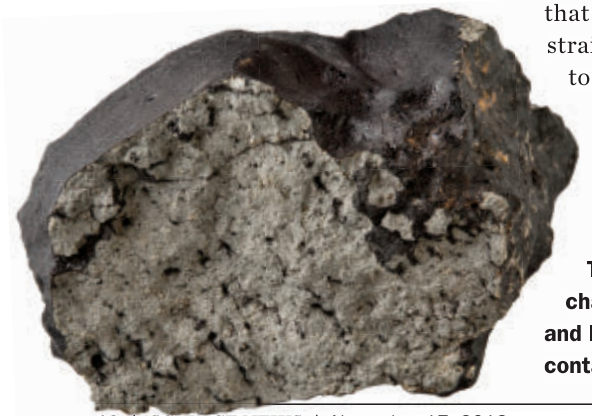
"It's really a great sample if you're interested in studying something that has more or less been delivered straight from Mars, uncontaminated, to the Earth," says planetary scientist Carl Agee of the University of New Mexico in Albuquerque.

Other scientists agree but don't rule out contamination entirely. "It sat around the desert for months," says planetary scientist Harry McSween Jr. of the University of Tennessee, noting that the meteorite probably wasn't collected under sterile conditions.

The meteorite provides evidence of weathering on Mars' surface, says Hasnaa Chennaoui Aoudjehane, a geologist at Hassan II University in Casablanca, Morocco, and coauthor of the report. "It's really the first time that can be shown in a Martian meteorite excluding any terrestrial contamination," she says. The team's findings are in line with observations of Mars made by spacecraft and rovers.

Tissint is a type of meteorite known as a shergottite, composed of volcanic rock. The shiny black coating on the meteorite chunks betrays the roasting they endured in Earth's atmosphere. Their rocky interiors are punctuated by black glassy bubbles and channels, formed when the impact on Mars created a shock wave that melted small pockets of rock. These glass bubbles contain a treasure trove of trapped Martian atmospheric gas and surface minerals.

"It's sort of like having a little Martian environment tucked away inside that meteorite," Agee says.



This 1.1-kilogram chunk of the Tissint meteorite shows distinct charring from Earth's atmosphere and has pockets of black glass that contain trapped gas from Mars.

Science & Society

"It's hard to predict currency values worse than the banks did." —GERD GIGERENZER

Most retractions not honest errors

Science journals pull most papers for fraud, plagiarism

By Tina Hesman Saey

Scientific misconduct — including fraud, suspected fraud and plagiarism — is the reason behind most retractions of papers published in scientific journals, a new study shows.

Only 21.3 percent of biomedical and life sciences studies pulled from scientific journals were withdrawn because honest errors invalidated the findings, researchers report in the Oct. 16 *Proceedings of the National Academy of Sciences*.

Retraction notices often don't explain why a study is being withdrawn, or they cover up the real reason for pulling a paper, says study coauthor Arturo Casadevall, a microbiologist at Albert Einstein College of Medicine in New York City and editor of the journal *mBio*.

To understand the scope of the problem, Casadevall and coauthors Ferric Fang and R. Grant Steen studied 2,047 retracted journal articles in the PubMed database, which references more than 25 million studies dating back to the 1940s. Of the retractions, 67.4 percent were due to scientific misconduct, the new study shows.

Retractions are up in part because publishers now use software to detect plagiarism and multiple publication of the same research. Plagiarism accounted for 9.8 percent and duplicate publication for 14.2 percent of retractions.

> "Misconduct is a phenomenon similar to doping in sport: It is essentially about gaining an unfair advantage over competitors."
> DANIELE FANELLI

If there is any good news, it is that fraud doesn't seem to be widespread, Casadevall says. Just 38 research groups were responsible for 43.9 percent of retractions for fraud or suspected fraud in biomedical papers.

The culture of science may be to blame for a recent increase in fraud: Journal publications are widely used to gauge a scientist's potential and success. "Misconduct is a phenomenon similar to doping in sport: It is essentially about gaining an unfair advantage over competitors," says Daniele Fanelli of the University of Edinburgh. But a rise in retractions doesn't mean that fraud is also increasing. "The fact that we went from zero retractions to 0.01 percent in a few decades is just an encouraging symptom of growing awareness," Fanelli says.

Pressure to publish in high-profile journals and bring in increasingly hard-to-get grant money breeds a climate ripe for wrongdoing. Such cutthroat competition is rife in countries with the highest incidence of fraud in the new study, including the United States, Germany, China and Japan, says Kalevi Korpela, a psychologist at the University of Tampere in Finland.

Banks confuse uncertainty, risk

Complex predictive tools may have obscured meltdown

By Bruce Bower

WASHINGTON — Major banks conduct an annual ritual of financial forecasting futility: Their complex risk models consistently flub predictions about the relative values of the dollar and the euro in the coming year, a new analysis finds.

Annual forecasts of currency values from December 2001 to December 2010, which guided banks' investment decisions, missed the mark nine out of 10 times, says psychologist Gerd Gigerenzer of the Max Planck Institute for Human Development in Berlin. Banks incorrectly foretold the fates of the dollar and the euro in the years leading up to, during and after the recent financial crisis.

Gigerenzer described his findings October 4 at "Reckoning with the Risk of Catastrophe," a meeting of scientists trying to devise ways to measure the probability of financial calamities, natural disasters and other catastrophes.

"It's hard to predict currency values worse than the banks did," Gigerenzer said. "Highly paid people produced worthless predictions."

The problem, he asserted, is that most risk modelers don't distinguish risk and uncertainty. Economic models assume that the financial world consists of known risks that can be calculated based on prior behavior of markets and other elements of the monetary system. But uncertainty rules in the real world, where risks can't be known in advance because a complex tangle of factors triggers new, extremely unlikely hazards.

Gigerenzer obtained data on annual currency forecasts of 22 international banks. The predictions hewed fairly closely to dollar and euro values from the previous year. Other than a relatively accurate December 2008 forecast, those predictions were off by about 25 cents.

Financial risk modelers at the meeting acknowledged past failures of their mathematical creations but described efforts to strengthen the current approach. Economist Brenda González-Hermosillo of the International Monetary Fund in Washington, D.C., said that she and her colleagues are developing a statistical toolkit to predict upcoming financial crises based on complex analyses of currency exchange rates, money movements across countries and other factors.

Mind & Brain

Teens keep cool to win a reward

Young people's brains take time for thoughtful choices

By Laura Sanders

The oft-maligned teenage brain is getting some reputation rehab. When offered the incentive of a modest reward in a recent experiment, young people ages 11 to 20 took more time than adults to make a thoughtful, reasoned decision.

That result, presented October 14, counters the image of a flaky, impulsive adolescent brain and shows that incentives may be a powerful way to curb reckless behavior.

"Teenagers are quite capable of waiting, as opposed to reacting impulsively," said study coauthor BJ Casey of Weill Cornell Medical College in New York City. The result "really flies in the face of some of my previous research and research by other investigators."

Casey and colleague Theresa Teslovich spotted the contemplative adolescent brain as participants had to decide which way a cloud of dots was moving across a computer screen. Random jitters of individual dots made it hard to detect the direction of overall motion. When playing for a reward — in this case, five arbitrary points — adolescents took longer than adults to decide. This delay, the researchers think, allowed adolescents to accumulate more information before making up their minds.

> "Teenagers are quite capable of waiting, as opposed to reacting impulsively."
> BJ CASEY

Brain scans helped the researchers pinpoint the neural origins of this teenage thoughtfulness. When points were on the line, both adults and adolescents had a boost of brain activity in the ventral striatum, a region that handles rewards. But there was a big difference between the younger brains and adult brains in other regions that deal with decision making. Compared with adults, adolescents showed much higher brain activity in the prefrontal cortex and parietal cortex, perhaps reflecting the buildup of observational information.

Finding that adolescents can be measured in their decision making is surprising, said neuroscientist Jay Giedd of the National Institute of Mental Health in Bethesda, Md. "It doesn't fit the stereotype," he said.

The results may be context-dependent, Giedd said. Other studies (and no doubt centuries of personal observation) argue that teenagers are more impulsive than adults. Teens have trouble keeping their eyes on a target when a distraction hovers nearby, for instance. But the new results are encouraging because they show that this impulsivity can be managed in certain situations, Giedd said. "It's there, but it's not something that's insurmountable." ■

Drug puts painful memories to bed

Experiment in sleeping mice may suggest PTSD treatment

By Laura Sanders

Fearful associations can be knocked back during sleep, research in mice shows. After mice received an injection of a drug, a nasty link between a scent and a painful foot shock faded as the rodents slumbered.

The results are preliminary but suggest that the hazy world of sleep, which lacks any particular real-world context, might be a good place to diminish painful memories in people with post-traumatic stress disorder.

Neuroscientist Asya Rolls of Stanford University and colleagues taught mice that when they smelled jasmine, a foot shock was not far behind. A day later, researchers wafted jasmine over sleeping mice to strengthen and solidify the scary link between the odor and pain. A day after that, the mice froze in fear when they caught a whiff of jasmine, even though the animals were in an entirely new room unassociated with the original shock.

But Rolls and her team could interrupt this sleep-strengthening process by injecting the antibiotic anisomycin into the amygdala, a brain structure involved in memory storage. Before the mice were exposed to jasmine during sleep, the researchers injected some of them with the drug. The next day, these mice didn't freeze as often as the mice that didn't get the drug.

During sleep, the mind is not rooted in any specific environment. So the effect of curbing traumatic memories in someone who is fast asleep wouldn't be linked to any specific setting, such as a doctor's office. This could protect a person from reexperiencing the trauma in other situations, Rolls said October 16.

What's more, because sleep is a brain state outside conscious control, it may offer access to memories that are locked up tight during waking hours, Rolls said. And reactivating traumatic memories during sleep may be less painful for people, sparing them the difficulty of reliving a traumatic experience while awake.

Recently, Rebecca Spencer of the University of Massachusetts Amherst and colleagues found that people's fearful memories get strengthened during sleep, work that implied that keeping someone awake could prevent the formation of unpleasant memories. The new study "puts an interesting twist on our work," she said.

7–8 percent | Estimated fraction of U.S. citizens who will have PTSD

11–20 percent | Estimated fraction of U.S. veterans of Iraq or Afghanistan wars who will have PTSD

MEETING NOTES

Stem cell implants for Parkinson's show promise in monkeys

Specialized human stem cells can mature in the brains of monkeys with a Parkinson's-like disease. That finding, presented October 15, suggests that stem cells may be able to replenish dying brain cells in people who have Parkinson's disease. Three months after transplantation, the human cells seemed to be flourishing in rhesus monkeys' brains. The cells assumed the triangular shape of neurons and sprouted long, elaborate projections that send and receive messages. "We were just blown away when we saw these cells," said study coauthor Dustin Wakeman of Rush University Medical Center in Chicago. Observations suggested that the cells produce the brain chemical dopamine, just like the cells that are destroyed in people with Parkinson's disease. *—Laura Sanders*

Hypochondria can be seen in the brain

The brains of hypochondriacs overreact to seeing words representing potentially innocuous health symptoms, a finding that may help explain how mild headaches morph into deadly brain tumors in the minds of people with an overdeveloped fear of illness. Brain scans of 34 people diagnosed with the disorder uncovered high activity in the rostral anterior cingulate and the amygdala, Daniela Mier of the University of Heidelberg in Germany reported October 16. That activity may represent an excessive emotional response, she said. *—Laura Sanders*

Tobacco compound protects against head injury

A substance in tomatoes, tobacco and dietary supplements fights the fallout after traumatic brain injuries in mice. After a damaging blow to the brain, mice that were given anatabine were able to find their way out of mazes faster than mice receiving a placebo. Derived from tobacco, anatabine works by curbing harmful inflammation that can result after a brain injury, neuroscientist Fiona Crawford of the Roskamp Institute in Sarasota, Fla., said October 14. Soldiers, athletes and other people at risk of head injuries may benefit from taking anatabine as a preventive. *—Laura Sanders*

Health & Illness

Heart drug lacks long-term benefit

Beta blockers don't protect against heart attack, stroke

By Nathan Seppa

Commonly prescribed drugs called beta blockers fail to protect against heart attacks and strokes even while helping to control heart rate and blood pressure, a new study finds. Beta blockers didn't lessen the odds of a heart-related death in heart attack patients or others at risk over a median follow-up of 44 months, researchers report in the Oct. 3 *Journal of the American Medical Association*.

The American Heart Association previously discouraged the long-term use of beta blockers in those with heart risk factors or as a post–heart attack treatment beyond three years. The new findings further dim the prospects for drugs that have been a standard treatment for decades.

"I think this study is valid," says Valentin Fuster, a cardiologist at Mount Sinai Medical Center in New York City who wasn't involved in the new work.

Once seen as a leading treatment for heart attack patients, beta blockers are losing their luster thanks to new drugs and surgical devices, he says. When beta blockers were introduced several decades ago, statin drugs for lowering cholesterol and mesh stents for propping arteries open were unavailable. The relative ineffectiveness of beta blockers in the new study reflects the effects of these other treatments, Fuster says.

Previous studies had suggested that beta blockers prevented heart attacks, but many of those were short-term analyses, says coauthor Sripal Bangalore, an interventional cardiologist at the New York University School of Medicine. He and an international team examined a registry of thousands of patients with a history of heart attack, coronary artery disease or coronary artery disease risk factors. When the researchers compared matching groups of people who differed mainly in whether they got beta blockers or not — nearly 22,000 participants in all — little or no difference emerged in rates of heart attacks, of strokes or of dying from a cardiovascular cause.

In the group with heart risk factors, those getting beta blockers actually fared slightly worse than those not getting them, the data show.

Doctors should take heed, Bangalore says. For treating high blood pressure, he says, "I would say there are other medi-

Lycopene may reduce stroke risk

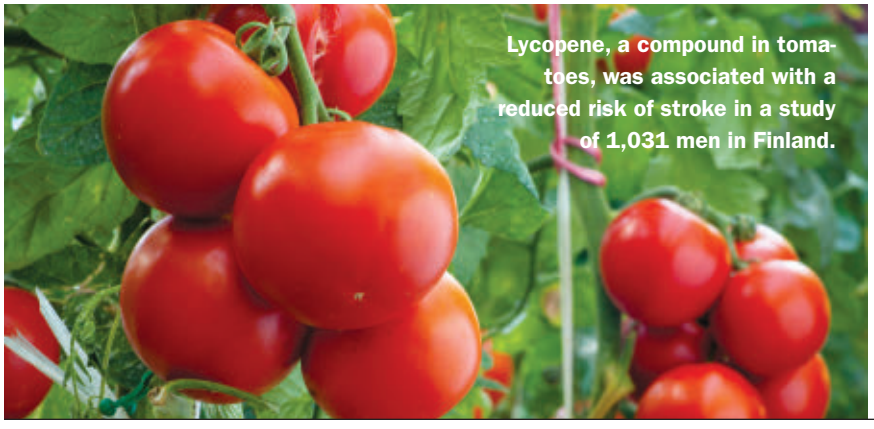
Men with high levels of tomato compound appear protected

By Nathan Seppa

Men with high blood levels of lycopene — the compound that makes tomatoes red — are about half as likely to have a stroke as those low on lycopene, researchers in Finland report October 9 in *Neurology*.

Some evidence suggests that lycopene quells inflammation, limits cholesterol production and inhibits blood clotting. But first and foremost, lycopene is a carotenoid, an antioxidant that sops up unstable molecules in the body called free radicals — reactive agents that can induce DNA damage, kill cells, attack proteins and contribute to blood vessel disease.

Lycopene's direct effect on stroke risk is less clear. Studies have found that a diet rich in fruits and vegetables, meaning plenty of carotenoids, seems to reduce the risk of heart disease and stroke. But few studies have analyzed lycopene's effect specifically on stroke risk over time, the researchers note.



Lycopene, a compound in tomatoes, was associated with a reduced risk of stroke in a study of 1,031 men in Finland.

FOTOKOSTIC/SHUTTERSTOCK

Jouni Karppi and colleagues at the University of Eastern Finland in Kuopio used blood tests to determine the lycopene levels of 1,031 men ages 46 to 65. Afterward, the men were monitored for a median of 12 years. The researchers tallied 67 strokes in the men over that span. Men with the lowest lycopene levels at the outset were more than twice as likely to have a stroke later as were those with the highest.

"This is a very good study, and I'm really surprised they were able to find this relationship with only 67 strokes," says Lyn Steffen, a nutritional epidemiologist at the University of Minnesota in Minneapolis.

The researchers accounted for factors such as smoking, body mass, blood pressure, LDL cholesterol, diabetes and any history of stroke.

9.7 percent | Fraction of Finnish men in lowest quartile of lycopene levels who had a stroke

4.2 percent | Fraction of Finnish men in highest quartile of lycopene levels who had a stroke

cations." And doctors prescribing beta blockers to prevent heart attacks in the belief that the drugs will save lives "may need to reconsider that option," he says.

Beta blockers mute the effects of adrenaline, preventing the heart from revving and easing blood pressure. But the drugs can cause headaches, fatigue, nightmares, poor exercise tolerance and sexual problems.

Beta blockers are still useful immediately after a heart attack and in patients with heart failure, a different condition in which the heart muscle has been damaged and struggles to pump out enough blood, the researchers note. "Decreasing the heart rate improves the efficiency of the heart muscle," Fuster says. Also, scarred heart muscle and adrenaline can both contribute to heart arrhythmia, Bangalore says, and beta blockers seem to help there. ■

It's not certain that the effect apparent in this study arises solely from lycopene. Tomatoes are loaded with it, but they have many other useful ingredients as well, says John Erdman, a nutritionist at the University of Illinois at Urbana-Champaign. High lycopene levels in the blood may suggest high tomato consumption, and therefore high levels of those other components, such as polyphenols, folic acid, and vitamins C and E. Polyphenols are potent antioxidants that show up in red and purple fruits, chocolate, coffee, red wine and vegetables.

Lycopene also appears in guava, red-fleshed papaya, pink grapefruit, red peppers, rose hips and watermelon.

Steffen says high lycopene levels might also flag people who have a healthy diet, ingesting lots of fruits, veggies and whole grains at the expense of red meats and processed grains. "In Finland they have this rye bread that's really wonderful as a whole grain. So the risk of stroke is lower not just because of lycopene but also from the background diet." ■

NEWS BRIEFS

Treating apnea improves blood pressure

Wearing a motorized breathing device while sleeping does more than relieve the daytime drowsiness caused by obstructive sleep apnea. A new study finds that many people with the breathing disorder who use the machine at night experience a decrease in blood pressure. Researchers at the University of Illinois at Chicago and the Edward Hines, Jr. VA Hospital in Hines, Ill., analyzed medical records of 221 veterans an average of 63 years old who began using a sleep apnea machine to improve their night breathing. Doing so knocked an average of seven points off their top blood pressure number and three off the bottom number over three to six months of use, the researchers report in the Oct. 15 *Journal of Clinical Sleep Medicine*. Blacks saw a substantial decline in both numbers whereas whites had a reduction only in the top number, on average. The study is first to document the effect of sleep apnea treatment on blood pressure in a real-world setting, the authors assert. —*Nathan Seppa*

Psoriasis drug works on some Crohn's patients

A drug already approved for the skin condition psoriasis also seems to help some people with Crohn's disease, a form of inflammatory bowel disease. The drug ustekinumab, marketed for psoriasis as Stelara, improved symptoms in more than one-third of people getting it, researchers report in the Oct. 18 *New England Journal of Medicine*. An international team of scientists randomly assigned 526 Crohn's patients who had failed to improve with standard medications to get an injection of ustekinumab or a placebo shot. After six weeks, 36.8 percent of patients getting the drug and 23.5 percent of those getting the placebo had shown symptom improvement. The drug inhibits two inflammatory proteins called interleukin-12 and interleukin-23. —*Nathan Seppa*

No luck predicting depression drug effectiveness

Patients with depression vary widely in how well they respond to medications. Scientists have suspected this arises from inherent genetic differences among people, but a new analysis of more than a half-million common genetic variations finds that none could predict the effectiveness of standard drugs taken by 1,790 people for severe depression, researchers report October 16 in *PLOS Medicine*. Some patients had taken a serotonin reuptake inhibitor while others got a noradrenaline reuptake inhibitor. Medical records were used to determine how well either type of drug worked, if at all. —*Nathan Seppa*

Vitamins fail to prevent colorectal cancer

Multivitamins don't protect against colorectal cancer, two studies find. In a study published in the Oct. 27 *Journal of the National Cancer Institute*, a Boston-based team of researchers reports that among more than 5,000 women, those randomly assigned to get vitamin B6, vitamin B12 and folic acid were no less likely to develop potentially precancerous colorectal polyps than were women getting a placebo. A separate study, reported online October 17 in the *Journal of the American Medical Association*, finds that among a group of more than 14,000 men, those randomly assigned to get a multivitamin were no less prone to colorectal cancer than men getting a placebo. That study found a weak reduction in overall cancer rates in men who took the multivitamins. —*Nathan Seppa*

Beginnings of BIONIC

Flexible, stretchable electronics could launch cyborg era

By Meghan Rosen

This stamp-on circuit and other new electronic devices are designed to conform to human tissue.

Michael McAlpine's shiny circuit doesn't look like something you would stick in your mouth. It's dashed with gold, has a coiled antenna and is glued to a stiff rectangle. But the antenna flexes, and the rectangle is actually silk, its stiffness melting away under water. And if you paste the device on your tooth, it could keep you healthy.

The electronic gizmo is designed to detect dangerous bacteria and send out warning signals, alerting its bearer to microbes slipping past the lips. Recently, McAlpine, of Princeton University, and his colleagues spotted a single *E. coli* bacterium skittering across the surface of the gadget's sensor. The sensor also picked out ulcer-causing *H. pylori* amid the molecular medley of human saliva, the team reported earlier this year in *Nature Communications*.

At about the size of a standard postage stamp, the dental device is still too big to fit comfortably in a human mouth. "We had to use a cow tooth," McAlpine says, describing test experiments. But his team plans to shrink the gadget so it can nestle against human enamel. McAlpine is convinced that one day, perhaps five to 10 years from now, everyone will wear some sort of electronic device. "It's not just teeth," he says. "People are going to be bionic."

McAlpine belongs to a growing pack of tech-savvy scientists figuring out how to merge the rigid, brittle materials of conventional electronics with the soft, curving surfaces of human tissues. Their goal: To create products that have the high performance of silicon wafers — the crystalline material used in computer chips — while still moving with the body. Beyond detecting bacteria to nip potential illnesses before they begin, such devices could comfortably monitor a person's vital signs and deliver therapeutic treatments.

Unlike Arnold Schwarzenegger's cinematic cyborg, which forced flesh and blood to fuse with a machine base, today's researchers focus on tailoring electronics to fit the human form. One group, led by materials scientist John Rogers of the University of Illinois at Urbana-Champaign, has created flat electronic "temporary tattoos" that stick to skin. This summer, the researchers invented an electronic finger sleeve that detects movement and touch. Now, a similar technology can hug the heart like cling wrap. Such a device could sense erratic beats and zap a spastic organ back into rhythm. Other inventions, implanted into the brain, might send out microshocks to jolt away an epileptic seizure.

Today's researchers focus on tailoring electronics to fit the human form.

In the last two years, another team, led by Zhenan Bao of Stanford University, has been working toward making stretchy, artificial skins from rubber and carbon nanotubes. The skins will feel like the real thing to the touch — and they will have a sense of touch too, electronically detecting changes in strain and pressure from a stretch or a pinch.

In the short term, flexible, stretchable electronics could help make medical devices smarter, by integrating sensors into sutures, surgical gloves or balloon catheters that feel their way through the passageways of a heart. Incorporating electronics onto (and into) human bodies for everyday use may follow close behind.

"We went from a computer that fit in a room, to a computer that goes on your desk, to a computer that can go in your pocket," McAlpine says. Joining computers to the body, he says, is "the next logical step."

Rogers is one of the scientists pushing the field forward. And last year, he put some skin in the game.

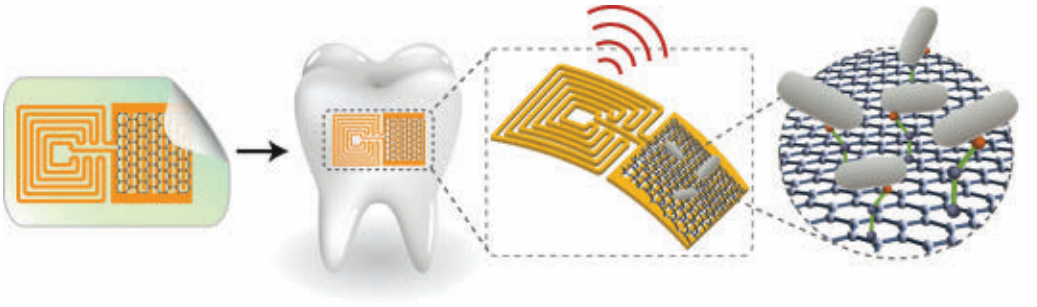
Stuck on skin

Silicon wafers are lousy for making skin electronics. "In terms of mechanics," Rogers says, "they're basically like a plate of glass." When the body twists and bends, they break.

But the appeal of silicon is its history. "There's been a half a century of global research and development to understand how to purify it, dope it, make devices out of it and manufacture with it," he says.

A typical computer chip has metal wires that carry a current along a rigid silicon base. Components etched into the base control the flow. Rogers' team is working with the brittle silicon to make it flexible and stretchable enough to ride atop skin. By creating ultrathin silicon ribbons instead of etching into a silicon block, the researchers have produced parts that bend without breaking. Think of how you can roll up a piece of paper but not a wooden board, Rogers says. The paper's thinness makes it supple.

In his team's epidermal electronic devices, squiggles of silicon ribbons snake across rubbery support surfaces. The squiggles join with gold to form the devices' sensors — for detecting temperature or pressure or strain — and link up in a mesh that puckers and flexes along with the sheet it is mounted to.



Toothy circuit
When transferred to a tooth, a graphene-based sensor printed on biodegradable silk could help fight disease. Such a device can detect the presence of bacterial intruders in the mouth and communicate its findings via wireless readout.

FACING PAGE: J. ROGERS/UNIV. OF ILLINOIS; THIS PAGE: M.S. MANNOOR *ET AL*/*NATURE COMMUNICATIONS* 2012

One day, a slim skin sticker designed by the team could be used to a track a person's health (*SN: 9/10/11, p. 10*). It would even be gentle enough for premature babies. The electronic gadget might also be tapped for nonmedical uses: Secret agents with an electronic sticker hidden under a shirt collar could pick up and send out conversations, an extra-covert way to "wear a wire."

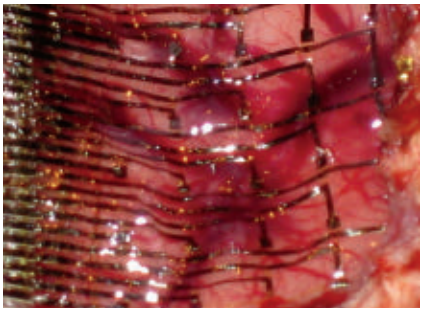
Already, Reebok is working with Rogers to develop a skin-mounted sports monitor designed to move with the body while tracking an athlete's health. Reebok's flexible device straps on instead of stamping on, "but it's a great first step in that direction," says Rogers.

While gadget lovers wait for the device to debut sometime later this year, Rogers and collaborators have moved beyond flat electronics into a third dimension. In August they reported inventing an electronic "finger tube" — a molded polymer sheath with built-in sensor disks of silicon and gold. For a snug fit, Rogers' team used a 3-D scanner to map a finger's form. He envisions the stretchy tubes will one day top the fingers of smart surgical gloves, to enhance the sense of touch for delicate operations.

Rogers is also teaming up with other researchers to apply the new technology to bigger body parts — such as hearts.

Keep the beat alive

When St. Louis surgeons remove a failing heart from a transplant patient, biomedical engineer Igor Efimov and his colleagues are among the first to know. They take advantage of the heart's last moments of life to test prototypes of a cardiac technology that might one day have the power to heal.



This flexible brain sensor can monitor activity more gently and accurately than current technologies.

Efimov and his team have joined with Rogers' group to develop the device, which slips around the heart and uses a low-energy method to gently calm spastic tremors. Jittery flutters called atrial fibrillations afflict millions of people worldwide and can bump up stroke risk.

A safe, effective atrial defibrillator exists, but it is bulky, with rigid electrodes and wires that eventually wear out, short-circuit or leak. What's more, "nobody wants to use it because it's too painful," Efimov says. The defibrillator uses so much energy to jump-start a heart that patients describe it as a mule kick to the chest. His team's method is more like a love tap; it's pain-free.

Inside the "heart sock" are printed sensors that monitor activity across the surface and stimulators that deliver tiny shocks when needed. And because the sock is light and floppy, it could outlast today's clunky cardiac equipment.

Recently, Efimov and colleagues have begun testing prototypes on donated human hearts. A partnership between Barnes Jewish Hospital and Efimov's lab at Washington University, both in St. Louis, delivers sick hearts from patients to scientists. When transplant patients get new hearts, researchers get to experiment on the old ones.

"It's a good deal," Efimov says. After the heart is pulled from the body and unhooked from its blood supply, the researchers have a short window of time before the heart shuts down. They shuttle it to the lab and conduct their experiments, laying pieces of prototype heart sock material on the organ to measure electrical activity and other properties. In the team's sensing tests so far, he says, it is "working really wonderfully."

Efimov has also stimulated rabbit hearts with a more complete version of the sock, and is planning to try it on the hearts of living dogs — the best animal model for human atrial fibrillation, according to Efimov. With so many people worldwide relying on defibrillators and other implanted heart devices, Efimov sees an obvious market.

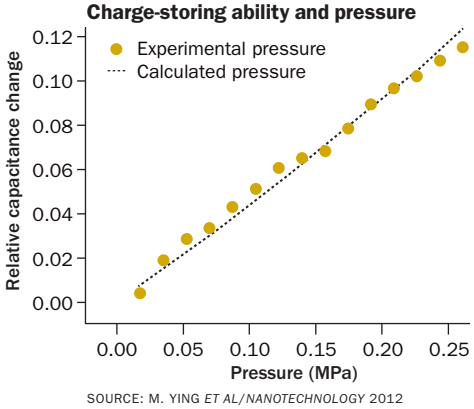
Though Efimov focuses on cardiac therapy, he has ideas for other uses for the technology. Scientists could use related devices on muscles or bones, he says, or to hook up human brains to the Internet. "There are so many applications," he says. "It's just amazing."

Handle with silk

A Web-browsing brain may sound like science fiction, but researchers have already figured out how to implant flat chips into the human brain to pick up neural signals and turn them into actions (*SN: 7/2/11, p. 26*).

But forcing flat electronics to lay against the soft, sloping surface of the brain is a delicate and tricky task. The device must physically touch the cortex and be stiff enough that surgeons can pass it through tiny openings in the skull. One of the best current technologies taps into neural activity by jabbing sharp pins into the brain where they contact clumps of brain cells. The pins

Touch sensitive Electronic finger sleeves (one below) might pave the way for human-machine interactions or find their way into smart surgical gloves. When squeezed, a sensor's ability to store an electric charge, its "capacitance," changes (graph at right).



SOURCE: M. YING *ET AL/NANOTECHNOLOGY* 2012

BOTH: J. ROGERS/UNIV. OF ILLINOIS, TOP: D.-H. KIM *ET AL/NATURE MATERIALS* 2010

mount to a rigid silicon chip.

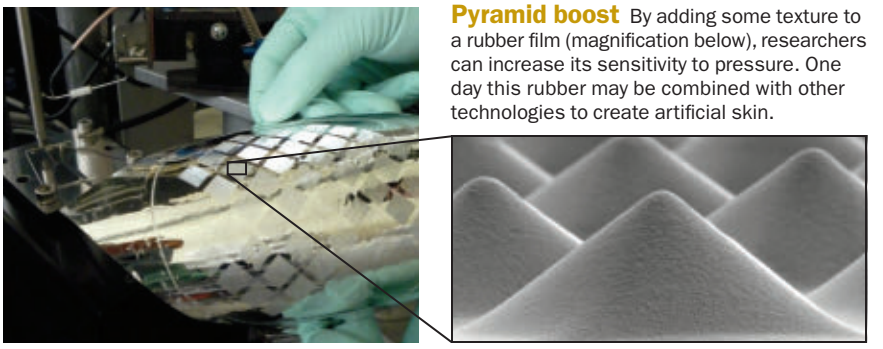
Though easy to handle, today's approaches irritate the tissue and can trigger long-term inflammation. Low-profile devices that instead sink into the brain's crevices and work with its micro-movements — bulges, contractions and pulses — could be less traumatic and longer lasting. If scientists can figure out how to work with them.

"You can't really hold or manipulate the device very well because it's so thin and flexible and sloppy that it's not even self-supporting," Rogers says. "So how do you move it around?"

One answer is silk. As with McAlpine's tooth sensor, thin films of silk may help scientists get a grip on flexible electronics. Because the films are stiff when dry, researchers can add a layer of mesh circuits and easily maneuver the films through holes in the skull and onto the brain. Doused with fluid, the film dissolves and the circuit snuggles against the brain's folds. Since the silk doesn't bother the body, film remnants can flush safely into the skull cavity (*SN: 11/3/12, p. 15*).

"It eventually degrades, and the body has a very low immune response to it," says biomedical engineer Fiorenzo Omenetto. To make the films, Omenetto and his team at Tufts University in Medford, Mass., process silk into its basic protein ingredients. First, they chop up silkworm cocoons, and then they boil the bits in a salt solution to break down the fibers. "It's like making pasta," Omenetto says. At the end of the entire process, what's left is a mixture of water and fibroin — a versatile silk protein that scientists can form into almost anything, including thin sheets.

In 2010, Rogers, Omenetto and colleagues tested a silk-coupled electronic device on a feline brain. They placed the silk-backed mesh circuit onto the visual cortex of an anesthetized cat and monitored brain activity. Compared to thicker devices, the mesh molded more closely to the brain and recorded stronger signals. In people, such flexible devices may one day control prosthetic arms, map brain activity or quell seizures in epileptic patients.



Pyramid boost By adding some texture to a rubber film (magnification below), researchers can increase its sensitivity to pressure. One day this rubber may be combined with other technologies to create artificial skin.

BOTH: BENJAMIN TEE, S. MANNSFELD *ET AL./NATURE MATERIALS* 2010

All-in skin

Instead of trying to make traditional electronic materials flexible, Stanford's Bao and colleagues are turning the goal around: They're trying to make flexible materials electronic. By layering thin textured films with carbon nanotubes, Bao and her colleagues are figuring out how to make touch-sensitive artificial skin — no rigid parts required.

Today's ultrasensitive strain sensors are built with a thin layer of silicon film. Pressing on the film changes the amount of current zipping through it, allowing the pressure to be measured. The gadgets are very sensitive, Bao says, but also very fragile. For the applications she is interested in, fragile doesn't work: "A lot of wear and tear will easily damage those kinds of devices."

In 2010, Bao's team made a sensing system that works a little differently by sandwiching a layer of microstructured rubber between two charge-holding metal grids. When pressure is applied to the grids, the amount of charge changes. The pattern of holes carved into the rubber bumped up its sensitivity: Even a butterfly-light touch compressed the cutouts, Bao and colleagues reported in *Nature Materials*.

Of course, metal tends to crack when bent. So last year, the researchers figured out how to give the sandwich's bread layers a little stretch.

They replaced the metal grids with carbon nanotubes, thin carbon wires that can handle extreme bending and still conduct a current. In this version, the sandwich's middle was a flat rubber film that wasn't so sensitive, but combining the technologies and spotting the resulting sandwiches onto another material could yield sensitive, stretchable artificial skin.

Such skin may one day patch areas of real flesh damaged by burns, for example. "Twenty years from now," Bao says, "I can definitely see some flexible sensor sheet that looks just like human skin and can be grafted onto wounds and function like real skin."

In many ways, Bao's artificial skin behaves like the real thing. But it has one big hurdle to clear: It still uses wires to send its messages to a computer. If the skin ever made its way into a prosthetic, it would need to relay signals wirelessly to the wearer's brain. "Ultimately we want the sensors to be talking directly to the neurons," Bao says.

She imagines a future in which a person's electronic skin and other implanted devices link up. A world where a fly lands on the artificial skin of a person's arm, which speaks to an electronic device in the brain, which tells the person to shoo the bug away with a flick of a supersensitive finger.

Today, researchers are buzzing along building bits of electronics that can be integrated into the body. Someday soon, they may cobble the pieces together and get them to converse in a truly bionic being. ■

Explore more

- D.-H. Kim. "Flexible and stretchable electronics for biointegrated devices." *The Annual Reviews of Biomedical Engineering*. August 2012.

Meghan Rosen is a former Science News *writing intern.*

Extremely bad weather

Studies start linking climate change to current events

By Janet Raloff

Texas spent 2011 baking. About half the state was gripped by what climate scientists described as an "exceptional" drought, one that goes beyond their categories of severe, or even extreme.

Texans are used to dry, but this was worse than the Dust Bowl and drier than the crippling decade-long drought of the 1950s. In fact, it was the driest year since record-keeping began in 1895. As rivers dried up and farmers scrambled to irrigate, many public water systems reported that they were within six months of running out of water. Agricultural extension agents pegged crop and livestock losses at a staggering $5.2 billion.

Problems that people hadn't anticipated started to pop up. In a state obsessed with football, Dallas had to close more than two dozen athletic fields as clay soils shrank and formed cracks more than half a meter deep. One county hired some 100 bridge and road crews to fix pavement cracks all summer long. The shifting soil twisted water mains, breaking more than 200 in Fort Worth alone, 20 in a single day.

And 2011 didn't bring bad weather just for Texas. At least 1,625 tornadoes touched down across the United States. Half a world away, heavy monsoons in Asia triggered record floods, causing tens of billions of dollars in damages.

Most recently in 2012, the U.S. Northeast was pummeled by Hurricane Sandy. Earlier in the year the nation faced blazing heat and a crop-slaying drought across the Midwest. From January through September, U.S. cities matched or broke more than 29,300 high-temperature records. By the end of September, nearly two-thirds of the contiguous United States was suffering moderate to exceptional drought — including 80 percent of the nation's farmland.

In the wake of such events, everyone from insurance companies to Congress, homeowners and government agencies has been asking whether global warming might have played some role. And scientists have been working on ways to figure out just how much of this weird weather has come from natural variability, and how much might be driven by warming from greenhouse gases.

"The breaking of records is the best indication that we're outside the normal range of simply weather," argues Kevin Trenberth of the National Center for Atmospheric Research in Boulder, Colo. Under normal variability, regions should experience the same number of high and low temperature records in any given year or decade, on average. "But we did some statistics on the first six months of this year," he says, "and there were around nine times as many records being broken on the high side as there were on the cold side."

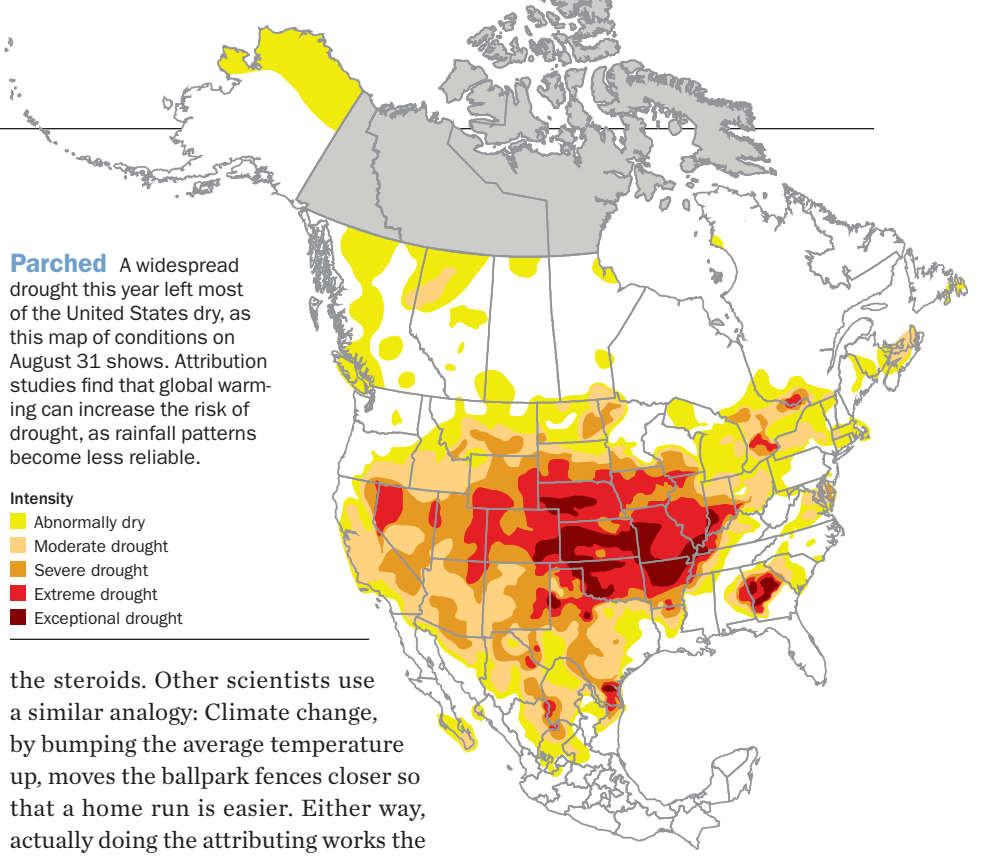
Such a short-term trend could be a fluke, but the same pattern shows up when scientists look back over decades. Work published in *Geophysical Research Letters* in 2009 showed that record highs and lows happened about equally in the

A cow's remains lie along a dried-up watering hole near Tulia, Texas, in July of 2011. That year was the state's driest since record-keeping began in 1895.

1950s, but from 2000–2009 record-high temperatures outnumbered record lows 2-to-1.

An approach that climate scientists call "attribution" may help explain this apparent rise in extremes. Initially, attribution studies looked for the drivers of climate change over decades, using computer simulations of climate and statistical analyses of past conditions. Such studies have helped show that human activities are contributing to rising temperatures, by establishing that observed changes cannot be explained without including the effect of greenhouse gases. Now, a twist on attribution studies is looking at whether a warming climate may be shifting the odds of extreme weather events such as floods, droughts and heat waves.

Knowing if extreme events will recur every few decades instead of once in a century is becoming vital for government agencies in charge of building codes, water supplies and emergency planning, says climatologist Thomas Peterson of the National Climatic Data Center in Asheville, N.C. "There's much each can do to adjust how they manage the environment and their budgets," he says, "as we understand how the odds of extreme weather are changing."



Parched A widespread drought this year left most of the United States dry, as this map of conditions on August 31 shows. Attribution studies find that global warming can increase the risk of drought, as rainfall patterns become less reliable.

Altered odds

Climate scientists have long warned that no single weather event — say, Hurricane Katrina — could be attributed to climate change. After all, even if warming doubled the number of category 5 hurricanes per year, it would be impossible to say whether Katrina was one of the extras. But in some cases researchers can now calculate whether climate change upped the odds of a major hurricane, heat wave or other type of event.

Some scientists have likened the effect of global warming on weather to the use of steroids by a baseball slugger, intensifying a hitter's power. If the player hits 10 percent more home runs, it's impossible to know which particular home runs were the result of drug use, but the chances of his hitting any one of them was 10 percent higher because of the steroids. Other scientists use a similar analogy: Climate change, by bumping the average temperature up, moves the ballpark fences closer so that a home run is easier. Either way, actually doing the attributing works the same way: Scientists calculate how climate change affects the odds of a given event happening.

This change is most evident so far for extreme heat. Many regions of the globe have begun experiencing spells of anomalous warmth — a trend that's only expected to build. An analysis in the September 11 *Proceedings of the National Academy of Sciences*, for instance, found that unusual summer heat — extremes characterized by seasonal temperatures at least 3.2 degrees Fahrenheit above the regional average — covered roughly 1 percent of the planet on average between 1951 and 1980. Over the next 30 years, the land area affected by extreme temperatures mushroomed to roughly 10 percent. Within a decade, the value could spike to 16.7 percent, concluded James Hansen of NASA's Goddard Institute for Space Studies in New York City and his coauthors (*SN: 9/8/12, p. 10*).

People may not notice warmer temperatures or other anomalies, however, when they fall in seasons that normally aren't the hottest, coldest, rainiest, driest or windiest.

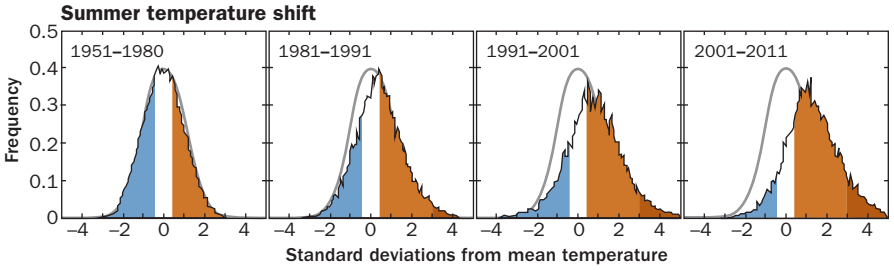
As Trenberth explains it, when temperatures in the U.S. midsection from March to May are a few degrees above normal, people might see it as a welcome respite from the chill. At a minimum, these are temperatures people will normally encounter at some point during the year. "It's when those record-breaking temperatures occur in June and July — as we had this year — that you exceed the bounds of previous experiences, and people suddenly take notice," he says. But the elevated heat on summer days does not necessarily have a greater effect on ecosystems than higher temperatures in other months, he says.

Markus Donat and Lisa Alexander of the University of New South Wales in Sydney pored over global temperature records for the same years as Hansen's study, but concentrated instead on daily temperatures. Compared with the earlier period, "we saw a skewing in the distribution of temperatures to warmer values," Donat says. The threshold temperature needed to qualify a day as being in the top 5 percent between 1951 and 1980 now occurs 40 percent more often, they reported July 31 in *Geophysical Research Letters*.

Neither of those studies tried to link these trends to global warming or associated human activities. That's where attribution science steps in, and it's challenging.

Scouting for a climate-change signa-

OPPOSITE PAGE: SCOTT OLSON/GETTY IMAGES; THIS PAGE: NOAA



Loading the dice New research shows that extreme summer heat, such as the 2010 heat wave that enveloped Moscow in smoke from wildfires (right), is becoming more common in the Northern Hemisphere. Average summer temperatures in 1951–1980 fell along a bell curve (gray), with as many cooler-than-normal days (blue) as warmer ones (orange). Over time, the distribution of Northern Hemisphere temperatures shifted to the right, or warmer. Scientists use the analogy that the weather dice have become loaded: The odds of hot temperatures in recent years would cover four and a half sides of a six-sided die instead of two sides as before. SOURCE: GISS/NASA

ture within transient events lasting just months and affecting only a small part of the globe is equivalent to hunting for a faint fingerprint amid the heavy boot prints of weather's natural variability.

The first big advance came in 2004 when Peter Stott of the Met Office, which is the United Kingdom's weather service in Exeter, England, and his colleagues linked Earth's globally warming surface temperatures to a savage heat wave in Europe the year before.

Over the summer of 2003, more than 70,000 excess deaths across 12 European nations resulted from what may have been the region's hottest protracted period in 500 years. Using temperature readings collected since the 1920s, computer analyses by Stott's group identified an increased chance of excessive warming in 2003 — at least a doubling — "attributable to human influence on climate." And by the end of the century, those analyses projected, "2003 would be classed as an anomalously cold summer."

Russian heat

The poster child for attribution science, however, may be the 2010 Russian heat wave. Blistering summer temperatures devastated regional crop yields, fostered widespread wildfires and killed thousands. It took quite a while to crunch the numbers, but two recent attribution studies now indict climate change as a coconspirator.

Earth's slowly growing fever played an increasing role in breaking July temperature records in Moscow over the last decade, according to climate simulations by Stefan Rahmstorf and Dim Coumou of the Potsdam Institute for Climate Impact Research in Germany. Their work, reported late last year in the *Proceedings of the National Academy of Sciences*, suggested an 80 percent likelihood that global warming intensified the 2010 Russian heat wave.

A Sept. 5 report in the *Journal of Geophysical Research* by Trenberth and John Fasullo, also of the National Center for Atmospheric Research, points to factors that may have set the stage.

Previous analyses had looked in Russia for evidence of what caused a huge high-pressure air mass to stall over the region, baking it dry with warm and stable sunny weather. "What we show," Trenberth says, "is that's really a mistake. A lot of things going on all around the world now appear very much related to the Russian heat wave." These included record-breaking high sea-surface temperatures covering an area from the Caribbean to the northern Indian Ocean and Australia. The analysis also linked Russia's heat to anomalous monsoon circulation patterns from Pakistan to South America and northeastern Australia.

Although a large share of these predisposing conditions trace to natural variability, Trenberth says, "it's also fairly clear that there was a significant climate change aspect," particularly in exaggerating sea-surface temperatures. The upper ocean's record heat set up atmospheric patterns that pushed conditions known collectively as the Mediterranean climate from southern Europe to Russia, where those conditions persisted for months.

Measuring that fingerprint

But most scientists aren't content to merely probe whether the severity of weather extremes can be attributed in some part to climate change. They'd also like to quantify how much of the blame climate change deserves.

One problem: Natural variability in Earth's climate makes some years warmer than others, says Richard Seager of Columbia University's Lamont-Doherty Earth Observatory in Palisades, N.Y. "The dominant features," he notes, "are El Niños, during which the global mean temperature goes up, and [countervailing] La Niña events where the global mean temperature goes down." But other factors — from volcanic eruptions and local cloudiness to human-caused changes like urban development and crop irrigation — can also affect winds, rainfall and sunlight.

This variability tends to smooth out on the global scale, as local effects blend together. "But as you move to smaller spatial and temporal scales," Seager says, "the amount of random variability in climate gets bigger and bigger relative to any global-warming signal."

He says that's why attribution studies have largely focused on weather events that tend to be regionally broad and long-lived.

As in Texas' scorching 2011 drought.

Meteorologist Martin Hoerling of

MIKHAIL METZEL/ASSOCIATED PRESS

NOAA's Earth System Research Laboratory in Boulder, Colo., and collaborators probed what drove Texas' recent drought, which set in months before a massive heat wave gave the region a double whammy. They found that drought has tended to precede extreme hot spells in the region.

For Texas, he says, "the dry antecedent conditions made the heat wave that much more extreme." Once soils dry out, there's no moisture to cool the environment through evaporation, so the heat just bakes the air and ground hotter and hotter. The 2011 extreme developed in part because of La Niña conditions, which as they cool the ocean surface in the eastern equatorial Pacific also tend to lead to drier weather in Texas. His team's findings have been submitted for publication.

Those results are consistent with findings published in the July *Bulletin of the American Meteorological Society*, which concluded that compared with the 1960s, global warming appears to have increased by 20 times the risk that extreme heat will accompany La Niña conditions in Texas (*SN: 8/11/12, p. 14*).

"Dryness alone would have explained more than half of how hot it was that summer," Hoerling says. It now appears that climate change contributed another 1 degree Fahrenheit — "or about 20 percent of the magnitude of the heat wave."

Don't underestimate the impact of just one extra degree, Seager warns. "It may be all you need to exceed some threshold, such as the temperature at which railway tracks buckle."

When it rains

Seager's team and others have also been probing recent changes in precipitation extremes against the backdrop of Earth's warming atmosphere. He says these studies show that wet years get wetter and dry years get drier — and the length of dry spells increases.

Overall, roughly the same amount of water is available to evaporate and rain down in any year. But because a warmer atmosphere can hold and transport more moisture, warming can ramp up the activity of the whole precipitation cycle, Seager notes. Not surprisingly, he says, rain gauge data have begun showing that "an increasing proportion of rain is falling in the heaviest rain events."

In the May *Journal of Climate*, Seager and his colleagues mapped the variability of rains and evaporation. Their attribution analyses showed increased variability in monsoons and other precipitation. The researchers concluded that these trends, "no longer natural but a mixed hybrid of [natural] variability and human-induced climate change, will only become more extreme."

But not every monster flood carries a climate-change signature. Take the unusually wet 2011 monsoon that submerged much of Bangkok and other parts of Thailand under 2.5 meters of water for up to two months, causing an estimated $45 billion in damage. Though the scale of the flooding was unprecedented, human development and water management policies bore most responsibility, according to an attribution study by Geert Jan van Oldenborgh of the Royal Netherlands Meteorological Institute in De Bilt and his colleagues.

Reported in the July *Bulletin of the American Meteorological Society*, their analysis showed that 2011 monsoon rainfall differed little from some in the recent past. What set last year apart, they concluded, was how locks and dam levels along catchment streams had been managed, together with a recent decision to foster the development of high-value properties within the region's floodplain.

Gales versus twisters

Among rainy extremes, hurricanes pose the biggest risks. Meteorological analyses predict that the total number of tropical cyclones should diminish dramatically in a warmer world, says climate scientist Kerry Emanuel of MIT. But those that do develop will increasingly be strong ones, he adds. And that's important, "since more than 80 percent of the damage produced by tropical cyclones in the United States come from storms category 3 or higher — the ones projected to increase."

In the Atlantic, hurricane power has more than doubled since the 1980s, Emanuel has found. This change tracks the uptick in sea-surface temperatures there over the last 30 years, which he says "is almost entirely due to greenhouse gases."

But despite the correlation, there isn't a long enough track record of hurricane numbers and intensities to establish causality, even if it is expected, Seager warns. Unlike temperature and rain data, which go back a century or more in many places, good tropical cyclone data date back only to the late 1970s and the widespread use of weather satellites to spot these storms.

What's more, reliable intensity data exist only for Atlantic hurricanes, Emanuel notes, where airplane

Extreme year 2011 was the costliest year on record for economic losses from natural disasters. A tally by reinsurance company Aon Benfield listed Thailand's flooding (shown) as the year's most damaging to structures, destroying more than 4 million homes and other buildings. Studies suggest Thailand's flood was not linked to global warming but that some other major events, such as the U.S. drought, were. SOURCE: AON BENFIELD

Event	Location	Dates	Deaths	Economic loss estimate (USD)
Flooding	Thailand	July 25–Nov. 30	790	$45 billion
Flooding	Australia	Dec. 21–Jan. 14	36	$30 billion
Severe weather/tornadoes	United States	April 22–28	344	$10.2 billion
Drought/wildfires	United States	Jan.–Dec.	n/a	$10 billion
Severe weather/tornadoes	United States	May 21–27	181	$9.1 billion
Hurricane Irene	U.S./Caribbean	Aug. 22–30	46	$8.6 billion
Flooding	China	June 1–24	239	$6.7 billion
Severe weather/tornadoes	United States	April 3–16	57	$5.3 billion

RUCHOS/ISTOCKPHOTO

reconnaissance has been able to measure wind speeds. Still, he argues, "the Atlantic link between hurricane power and sea-surface temperature for the tropical summertime is really spectacular — and hard to deny."

In an analysis in the March *Nature Climate Change*, Emanuel and colleagues used attribution to project trends for Atlantic hurricane development over the next century. Climate change, they showed, "has a negligible effect on common small storms, but increases the intensity of large [hurricanes]." Warming will make storms causing monster damage more frequent, they say.

The role of global warming in tornadoes is far less certain.

Yet after the United States was hammered last year by a record number of twisters for a single month — 758 in April — and seven that caused at least $1 billion in damages each, the public and policy makers have been clamoring for an explanation, says Harold Brooks of NOAA's Severe Storms Laboratory in Norman, Okla. Unfortunately, he says, the limitations on attributing hurricanes to climate change pale in comparison to what little can be said about tornadoes.

2011 twister numbers "were ridiculously high — absolutely off the charts," Brooks says. But this year, tornado rates are about the lowest on record. "That's what we mean by high interannual variability," he says.

As with hurricanes, historical data on tornado occurrence was spotty until widespread radar began in the 1970s and the National Weather Service started rating tornado intensities. Yet even today, those intensity ratings remain a judgment call, Brooks notes, because wind speeds have been measured directly for only a handful of twisters. The rest have been inferred from the damage caused. And that's problematic because the structural integrity of what's in a tornado's path can vary greatly, as can the experience of those who evaluate storm damage.

Global warming may be driving real changes in tornado numbers or intensities, Brooks concedes. But because their numbers vary so much from year to year, his analyses suggest that it could take another century before scientists can gather enough data for a compelling signal to emerge.

On the horizon

For now, running mammoth climate models and analyzing their outputs to find a global-warming signal takes nine months to a year — even for events as big as the Texas and Russian heat waves, notes Hoerling. "It's tough to push it faster than that."

But scientists would like to. And an experimental program has begun spitting out predictions for weather events expected in days to weeks. The analyses were developed at the University of Cape Town, South Africa and are now being fine-tuned in collaboration with researchers at the Met Office and Lawrence Berkeley National Laboratory in California.

"Our forecast system is not just looking for major weather events, but for 'impact' events," explains climate researcher Dáithí Stone of the Berkeley lab. "Like what's the chance of flooding in a certain area, and has that changed because of our emissions?"

These forecasts attempt to address in real time whether greenhouse gas emissions share some blame for a severe weather event. During the first few years of testing, the simulations failed to forecast extreme events in advance with accuracy at the regional level, Stone says. So now the team is refining these analyses in hopes of discerning future details of such regional events.

"We're not entirely sure if that is possible," Stone concedes. "But we also won't know without trying." ■

Explore more

- Learn more about extreme events in 2011 at www.noaa.gov/extreme2011
- T.C. Peterson and P.A. Stott, eds. "Explaining extreme events of 2011 from a climate perspective." *Bulletin of the American Meteorological Society*. July 2012. See bit.ly/BAMSattrib

Attributing extremes

Recent attribution studies look for the fingerprint of climate change on weather events. Not all types of extreme weather have been linked to climate change, and some are harder to study than others.

Heat versus chill Regional heat waves have shown the strongest signature of global warming. A stable climate exhibits as many warm as cold extremes on average, yet in recent decades new heat records vastly outnumber those for extreme cold snaps — a trend that has been growing.

Drought and floods Studies have been linking global warming with extremes in rainfall. So when it rains, it can really pour — and when it doesn't, a dry spell can persist far longer than was typical in former decades. Drought then boosts the impact of local warming, fostering especially prolonged, blistering heat spells. Attribution studies have also found that an extended drought conspired with global warming to foster the unprecedented Texas heat wave of 2011.

Hurricanes Recent attribution analyses find that warming sea-surface temperatures in recent decades have preceded a suspicious increase in hurricane intensity — at least in the Atlantic, for which the best data exist. Projections of future hurricanes indicate that their actual numbers will fall with increased warming, although the incidence of the most extreme storms will increase.

Wildfires The average size of wildfires in the United States so far in 2012 (182.4 acres for January through September) is the largest since 2000 for those months. The total area burned, 8.8 million acres, is the second highest since 2000. Studies have linked climate change to more persistent droughts, which up wildfire risk.

Tornadoes The most extreme among storms, tornadoes currently show the greatest year-to-year variability. The United States saw 1,625 twisters in 2011, racking up more than $28 billion in damage. So far, 2012 has proven an exceptionally quiet tornado year. But if there is a link between twister numbers or intensities and climate change, it may not show up for perhaps another century, owing to a lack of reliable long-term data on these storms. —*Janet Raloff*

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Air: The Restless Shaper of the World

William Bryant Logan

It's what we breathe. On the move, it brings wind and weather. As it vibrates, it communicates sound. It's hard to imagine a facet of life in which air is not a prime player. That's Logan's thesis, and he has constructed a veritable symphony of variations on it.

An arborist by profession and aviator by avocation, Logan takes readers from the soil, through plant roots, into the near surface air and then on up above the clouds. In most instances, the transitions work — if not seamlessly, at least engagingly. And that's because he doesn't present a musty treatise on air. Earth's atmosphere is merely the theme about which his anecdotes pirouette.

And there are plenty of anecdotes. Some are personal; Logan relates his experience of 9/11 in New York City, in which caustic gunk rained down on trees under his care. In chapters on flight, in addition to gee-whiz statistics on how birds and insects wing it, he tells the story of wingless critters that rely on breezes to migrate. Then there are tales of hang gliders out West riding thermals to heights of 7,300 meters (24,000 feet) — altitudes normally reserved for airliners with pressurized cabins.

A few chapters, regrettably, drift afield. Sections on parrot calls and bat echolocation will at least entertain. But when Logan moves on to human song, the narrative falters. It almost feels as though he felt compelled to devote a few chapters to people, and suddenly the book begins to reflect on scripture, pre-Christian mythology and philosophy. But these chapters are minor misses in an otherwise fascinating attempt to see our world through one volatile common denominator. — *Janet Raloff*

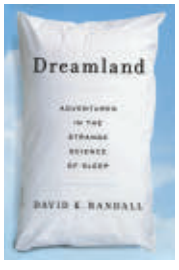
W.W. Norton & Co., 2012, 416 p., $26.95

Dreamland

David K. Randall

In 1994, an earthquake knocked out electricity in Los Angeles, delivering previously unknown darkness to many residents. Some were alarmed by a silvery light in the black sky. Until then, apparently, the only Milky Way they had ever seen was a candy bar. But perhaps they got some good shut-eye that night.

It wasn't always this way, Randall writes. People evolved to sleep long hours in a world that got very dark and stayed that way, every night. But modern conditions and lifestyles have left many people short on sleep. Ambient light — which sabotages release of sleep-inducing melatonin — is just one of the many risk factors that Randall investigates in making the case for getting more sleep.



"Without deep sleep, our brain morphs from being our greatest evolutionary asset to our greatest weakness," Randall writes. In the Gulf War, troops chronically short on rest unwittingly killed their allies. Since then scientists have designed wristwatch-sized sleep monitors that gauge a soldier's fatigue level. The devices could be standard gear by 2020. "Friendly fire may become a thing of the past," he says.

Progress elsewhere is slower. The siesta is under attack, for example, even as research finds that naps aid the ability to recognize patterns, recall lists and handle disturbing images.

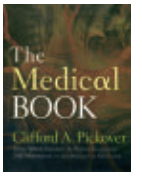
Dreamland also explores dreaming, of course, and covers apnea, sullen teenagers, sleepwalking, sleep talking, post-sleep grogginess and parasomnia, when half-asleep people perform tasks they can't remember later. Randall is thorough. If you've got a sleep problem, it's probably in here — even if it's just plain old insomnia. But, alas, this book won't put you to sleep. — *Nathan Seppa*

W.W. Norton & Co., 2012, 290 p., $25.95

Taking on Water

Wendy Pabich

In this educational memoir, an environmental scientist challenges herself to reduce her water footprint. *Sasquatch Books, 2012, 256 p., $21.95*



The Medical Book

Clifford A. Pickover

Bloodletting, the smallpox vaccine and organ transplants are all described in this history of 250 medical milestones. *Sterling, 2012, 528 p., $29.95*

Working on Mars

William J. Clancey

A NASA scientist takes readers behind the scenes of the Mars rover program to learn how humans and robots work together to explore an alien environment. *MIT, 2012, 310 p., $29.95*

The Mating Lives of Birds

James Parry

Avian masters of elaborate courtship displays take center stage in this colorful account of sexual evolution gone wild. *MIT, 2012, 160 p., $29.95*

Addiction by Design

Natasha Dow Schüll

An anthropologist journeys into the world of electronic gambling, seeking to learn how slot machines and other games work on the minds of those who play them. *Princeton, 2012, 442 p., $35*

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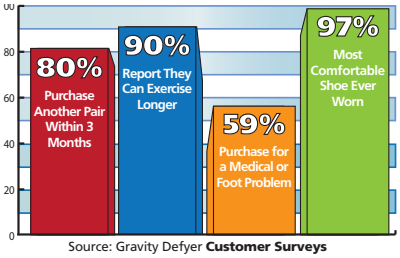

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Quick facial thinking

I have always found it remarkable that the average person can identify probably thousands of individuals by face ("Face smarts," *SN: 10/6/12, p. 20*) and perhaps hundreds by voice, as well as some just by their gait. Clearly such identification at a distance must have been a crucial survival advantage during our evolution; this unfortunately suggests to me that the larger threat to earlier humans was not lions or tigers and the like, but rather other members of our own species.

Peter Benson, North Oaks, Minn.

Timing human history

"No home for *Homo sapiens*" (*SN: 10/20/12, p. 9*) says that the Khoisan separated from the rest of humanity "at least 100,000 years ago." For much (if not all) of that time, the Khoisan have had contact with other humans, and we can assume there has often been some interbreeding. If the Khoisan genome has incorporated sufficient DNA from other branches of the human family, the date of the split would look more recent than it actually was. Do the researchers have an earliest plausible date for the split? Is that date early enough that the split could have happened when *Homo sapiens* was first emerging, rather than after our species was well-established? And finally, if the split might be that ancient, could the Khoisan and the rest of us have been on the way to becoming separate species had it not been for adventurous sex?

Tim Cliffe, Emmitsburg, Md.

The researchers do not offer an earliest possible date for the Khoisan's split from other populations, although 100,000 years is in line with other estimates. They do acknowledge that Khoisan mating with other populations could cause underestimates of when the Khoisan actually diverged. The estimated sizes of past populations also affect divergence dates. —Erin Wayman

Test for Alzheimer's idea

"Alzheimer's protein could help MS" (*SN: 9/22/12, p. 14*) is very interesting, but it would be difficult to do experiments in people — at least before we have some indication that it might work. One approach would be to compare the prevalence of MS in people with and without Alzheimer's. If it's lower in people with Alzheimer's, that might be an indication that the idea is worth pursuing in people.

Ted Grinthal, Berkeley Heights, N.J.

Don't try at home

"Dip your finger in water and then quickly dip it in molten lead..." This opening sentence in "Bubble-free boiling" (*SN: 10/6/12, p. 16*) makes me cringe. It's scary to think of inexperienced people doing this on their own.

Bob Eramia, via e-mail

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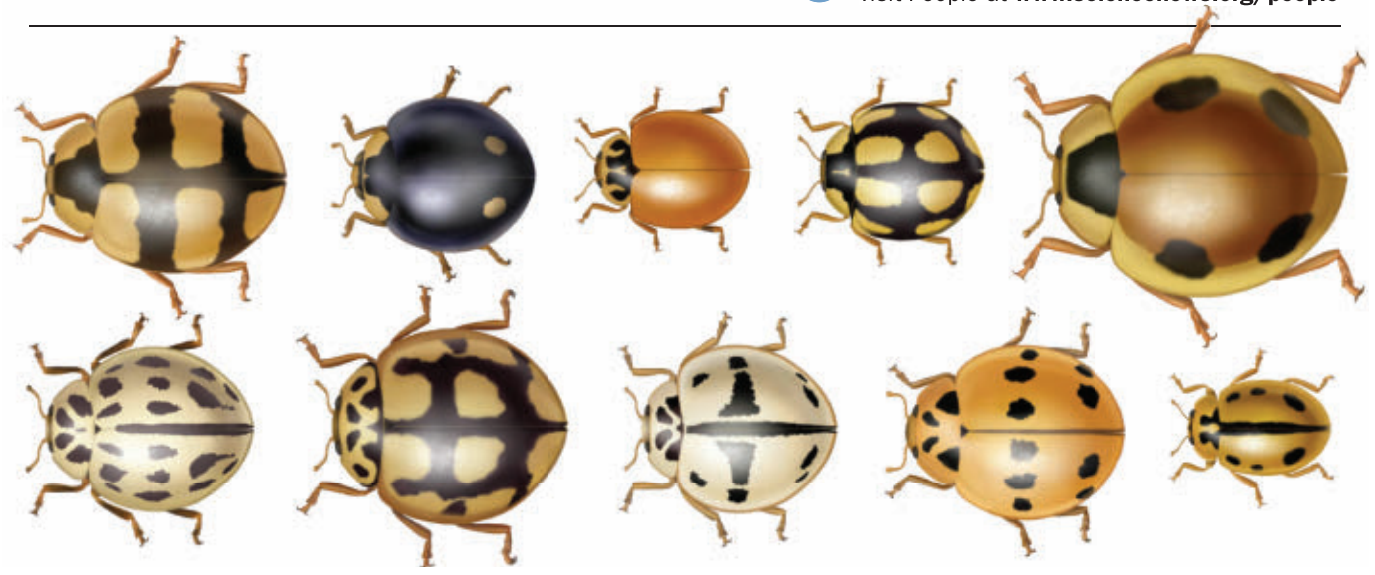

Insect illustrator

For 10 years, Taina Litwak's job was to draw almost nothing but mosquitoes. As a science illustrator in Washington, D.C., for the Walter Reed Army Institute of Research, Litwak helped document disease-transmitting species that might endanger soldiers overseas.

Today, Litwak's work offers a bit more variety: She's an "art department of one" in D.C. for the U.S. Department of Agriculture's Systematic Entomology Laboratory. She helps scientists describe insects that threaten crops or forests, as well as bugs that could kill these pests. This means illustrating beetles, flies, wasps, moths and other creepy-crawlies, enabling researchers to identify species more accurately.

Litwak gives insects "almost a life on the page," says Matt Buffington, a research entomologist at the USDA. Journal articles can be dry, he says, but her illustrations remind readers that a real animal is involved.

Litwak studied biology and printmaking in college but didn't consider a career in science illustration at the time. "I would have pooh-poohed it because it was neither fish nor fowl," she says. She pursued art after graduating and soon got tired of day jobs such as waitressing and landscaping. In 1983, Litwak started drawing mosquitoes for Walter Reed, eventually getting two species named after her. She later worked as a freelance illustrator, with assignments ranging from a rodent-control manual to *Science News* illustrations to medical drawings for legal exhibits.

Scientific illustration isn't the most glamorous artistic path to pursue. "In the pecking order of illustrators, science illustrators are on the bottom," she says, the thinking being that "we just copy things, we're technical, we don't express ourselves." But Litwak finds the work rewarding. "Part of the reason I really like what I do is that it encourages people to look at things.... People don't just observe stuff enough."

At the USDA, Litwak draws with pencil while peering at specimens through a microscope, then scans and paints the picture digitally. Her subjects have included wood-boring beetles and a wasp that kills potential pests of cucumber and melon crops. In 2010, Litwak won an award from the Illustrators Club of Washington D.C., Maryland and Virginia for a drawing of a long-horned beetle from the Caribbean (shown, right). "He's a real cutie," she says. — *Roberta Kwok*

As part of her work for the U.S. Department of Agriculture, illustrator Taina Litwak drew a series showing ladybird beetles (above) that could potentially eat pests. Litwak won an award for this illustration (below) of the beetle *Elaphidion costipenne*, a long-horned, wood-boring species from the Caribbean.

ALL IMAGES: T. LITWAK

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Richard Karn, North Canton, Ohio

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The made in North Canton, Ohio EdenPURE® carries a 60-day, unconditional no-risk guarantee. If you are not totally satisfied, return it at our expense and your purchase price will be refunded. No questions asked. There is also a 3 year warranty on all parts and labor.

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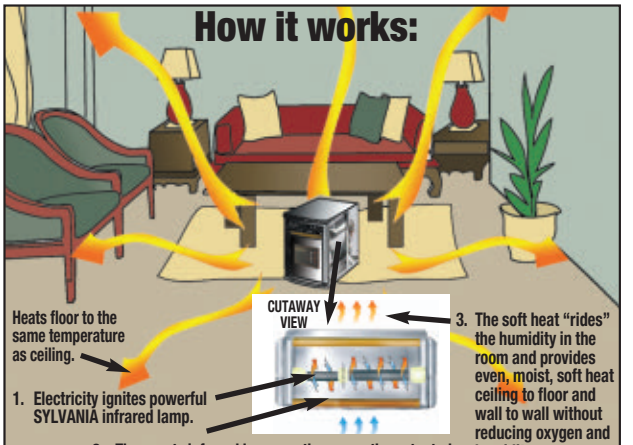
As Al Borland on Home Improvement I was the man with all the answers. However, as Richard Karn I still look for money saving and efficient heating in my home. I have an EdenPURE® Infrared Portable Heater in my California home and like millions of others found it to be a super-safe, reliable source of portable heat all year long.

How it works:



SYLVANIA is a registered trademark of OSRAM SYLVANIA Inc. used under license.

Richard Karn is a paid spokesperson for EdenPURE®.

RICHARD KARN'S SAVINGS COUPON

The price of the EdenPURE® Model 750 Heater is $449 plus $27 shipping and the price of the Personal Heater is $372 plus $17 shipping, but, with this savings coupon you will receive a $202 discount on the Model 750 and a $175 discount on the Personal Heater with free shipping and be able to get the Model 750 delivered for only $247 and the Personal Heater delivered for only $197.

The Personal Heater has an optional remote control for only $12. The Model 750 remote is included in the price.

Check below the number you want (limit 3 per customer)

☐ Model 750 with remote, number ____ ☐ Personal Heater, number ____

☐ Optional Personal Heater Remote $12, number ____

- To order by phone, call TOLL FREE **1-800-315-1257 Offer Code EHS7167**. Place your order by using your credit card. Operators are on duty Monday - Friday 6am - 3am, Saturday 7am - 12 Midnight and Sunday 7am - 11pm, EST.
- To order online, visit **www.edenpure.com** enter **Offer Code EHS7167**
- To order by mail, by check or credit card, fill out and mail in this coupon.

This product carries a 60-day satisfaction guarantee. If you are not totally satisfied return at our expense, and your purchase price will be refunded – no questions asked. There is also a three year warranty.

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP CODE _____

Check below to get discount:

☐ I am ordering within 10 days, therefore I get a $202 discount plus Free shipping and my price is only $247 for the Model 750 Heater.

☐ I am ordering within 10 days, therefore I get a $175 discount plus Free shipping and my price is only $197 for the Personal Heater.

☐ I am ordering past 10 days, therefore I pay full price for the Model 750 or Personal Heater plus shipping and handling.

Enclosed is $_____ in: ☐ Check ☐ Money Order (Make check payable to EdenPURE®) or charge my: ☐ VISA ☐ MasterCard ☐ Am. Exp./Optima ☐ Discover/Novus

Account No. _____

Exp. Date _____/_____

MAIL TO: EdenPURE® Offer Code EHS7167
7800 Whipple Ave. N.W., Canton, OH 44767

How to Outsmart a Millionaire

Only the "Robin Hood of Watchmakers" can steal the spotlight from a luxury legend for under $200!

I wasn't looking for trouble. I sat in a café, sipping my espresso and enjoying the quiet. Then it got noisy. Mr. Bigshot rolled up in a roaring high-performance Italian sports car, dropping attitude like his $22,000 watch made it okay for him to be rude. That's when I decided to roll up my sleeves and teach him a lesson.

"Nice watch," I said, pointing to his and holding up mine. He nodded like we belonged to the same club. We did, but he literally paid 100 times more for his membership. Bigshot bragged about his five-figure purchase, a luxury heavyweight from the titan of high-priced timepieces. I told him that mine was the ***Stauer Corso, a 27-jewel automatic classic now available for only $179.*** And just like that, the man was at a loss for words.

Think of Stauer as the "Robin Hood of Watchmakers." We believe everyone deserves a watch of uncompromising precision, impressive performance and the most elegant styling. You deserve a watch that can hold its own against the luxury classics for a fraction of the price. You'll feel the quality as soon as you put it on your wrist. This is an expertly-crafted time machine... not a cry for attention.

Wear a mechanical masterpiece for only $179! We surveyed our customers. As intelligent, high net worth individuals, they have outgrown the need to show off. They have nothing to prove; they already proved it. They want superb quality and astonishing value. And that's exactly what we deliver.

The Stauer ***Corso*** is proof that the worth of a watch doesn't depend on the size of its price tag. Our factory spent over $40 million on Swiss-made machinery to insure the highest quality parts. Each timepiece takes six months and over 200 individual precision parts to create the complex assembly. Peer through the exhibition back to see the 27-jeweled automatic movement in action and you'll understand why we can only offer the ***Corso*** in a limited edition.

Our specialty is vintage automatic movements. The ***Corso*** is driven by a self-winding design, inspired by a 1923 patent. Your watch will never need batteries. Every second of power is generated by the movement of your body. The black dial features a trio of date complications including a graphic day/night display. The ***Corso*** secures with a two-toned stainless steel bracelet and is water-resistant to 3 ATMs.

Your satisfaction is 100% guaranteed. Test drive the Stauer ***Corso***. If you don't love it, send it back within 30 days and we'll refund every dollar of your purchase price. Spending more doesn't make you smarter. But saving thousands on a watch this stunning will leave you feeling (and looking) like a genius!

Another Stauer Exclusive Not In Stores

Stauer Corso Timepiece—~~$495~~ ***Now $179*** *+S&P* ***PLUS*** **receive the Stauer Flyboy Optics™ Sunglasses FREE!**

Call now to take advantage of this limited offer with our 30-day money back guarantee.

1-800-859-1626

Promotional Code CSW245-01
Please mention this code when you call.

Exclusive OFFER!

Order the Stauer Corso and these Stauer Flyboy Optics™ Sunglasses (a $99 value) are yours ***FREE****!*

Limited to 4500 pieces... Order Today!

Stauer has a Better Business Bureau Rating of A+

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Stauer®

27-jeweled Vertex automatic movement - Interior dials - Transparent caseback - Dual-toned stainless steel case and bracelet band fits wrists 6 ½"–9"