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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ APRIL 24, 2010

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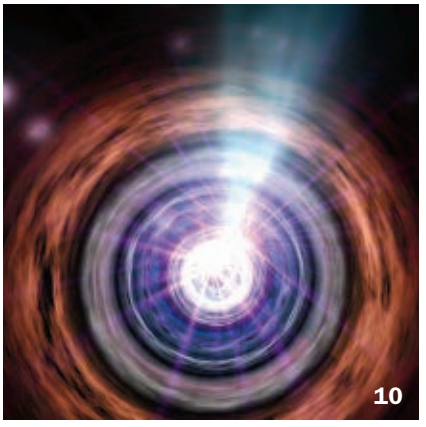
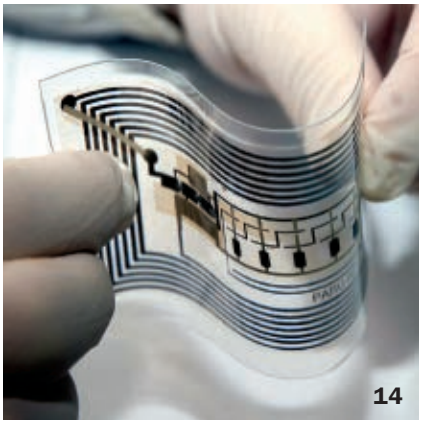
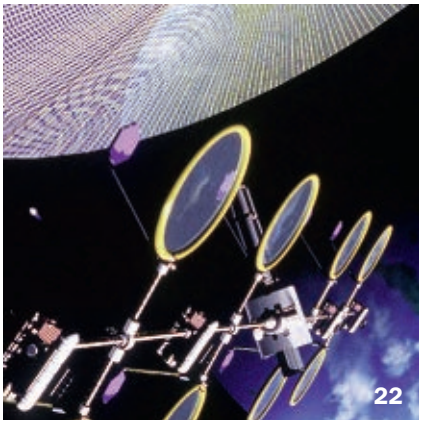
APRIL 24, 2010 • VOL. 177 • NO. 9







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Wildflowers are among the species now growing below the blasted-out crater of Mount St. Helens.
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ScienceNews
MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

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Texterity Digital edition provided by Texterity, www.texterity.com
Science News (ISSN 0036-8423) is published biweekly, for $54.50 for 1 year or $98 for 2 years (international rate $80.50 for 1 year or $161 for 2 years) by Society for Science & the Public, 1719 N Street NW Washington, D.C. 20036. Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.
Subscription Department: PO Box 1205, Williamsport, PA 17703-1205. For new subscriptions and customer service, call 1-800-552-4412.
Postmaster: Send address changes to *Science News*, PO Box 1205, Williamsport, PA 17703-1205. Two to four weeks' notice is required. Old and new addresses, including zip codes, must be provided.

FROM THE EDITOR

An intelligent ET would probably just stay home

Apart from jokes about how hard it is to find intelligent life on Earth, let alone in the rest of the galaxy, the possible existence of extraterrestrial beings — and the lack of contact with them — poses a perplexing issue.

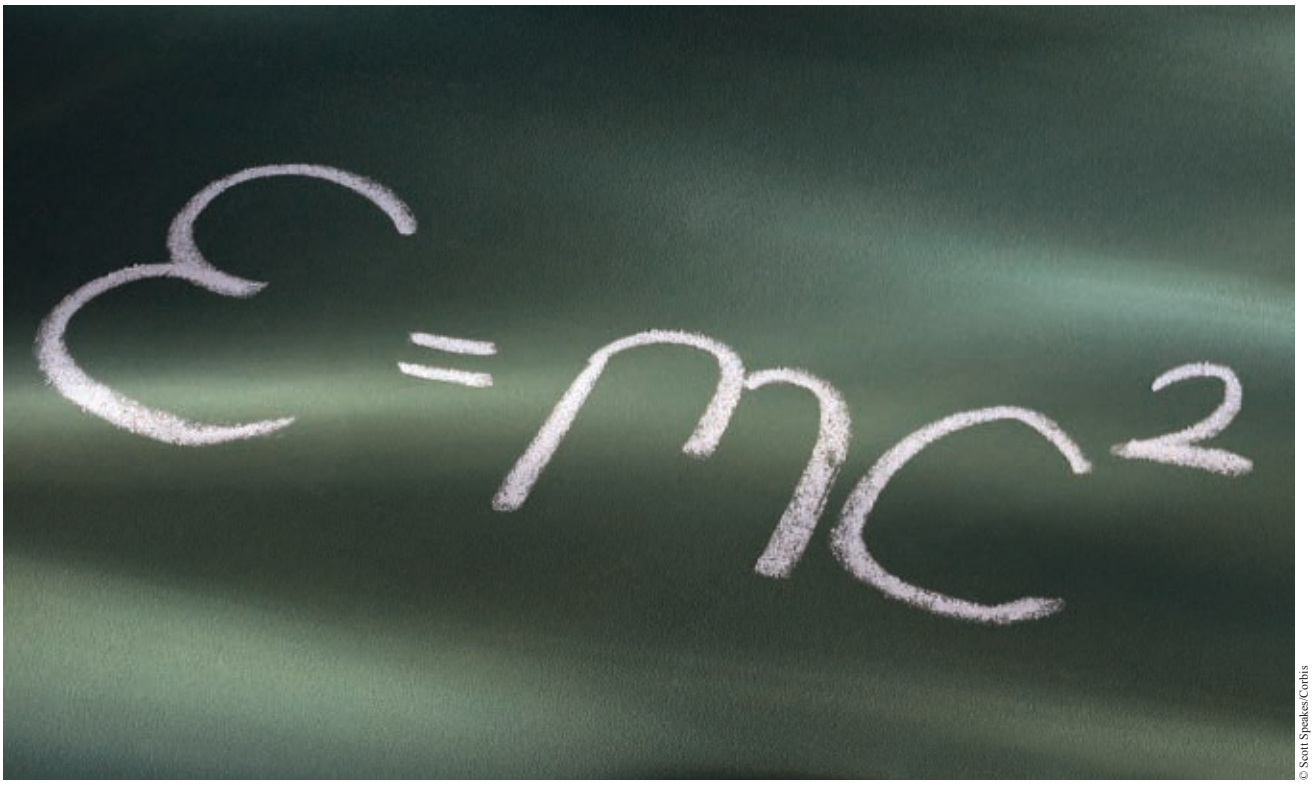
Because the galaxy is several billion years older than the Earth, planets around distant stars have had plenty of time to produce civilizations that would by now possess technology millions of years beyond current human capability. Presumably those advanced aliens would have built vessels permitting easy interstellar travel and so should be conducting regular tours to their favorite Earthly vacation spots. But as the famously sagacious physicist Enrico Fermi long ago observed, alien life is conspicuous in its absence. "Where is everybody?" Fermi asked. Ever since, experts and amateurs alike have sought reasons why the best response to Fermi's question is something other than simply concluding that no aliens exist.

Of course, proving alien life's existence would not require an actual visit from Klaatu and Gort or those Witch Mountain kids. A text message or even a Morse Code telegram would be evidence enough. But as Elizabeth Quill points out on Page 22, human strategies for finding such a signal have probably been attuned to the wrong medium: the electromagnetic waves, basically radio, that represent a transient phase in Earth's communication technology. Seeking signs of ET by listening to radio waves is like trying to watch ESPN on a TV with rabbit ears.

So searchers for extraterrestrial intelligence are now attempting to imagine other ways that more advanced societies might advertise their presence. It may be, though, that they are not advertising at all and would prefer to conceal their existence from other civilizations. Because if anybody has developed high-speed interstellar spacecraft technology, the galaxy is a very dangerous place.

Imagine a ship only the mass of the space shuttle — at a mere 20 percent of the speed of light, its kinetic energy would exceed that of 15,000 hydrogen bombs. You wouldn't want to invite a visitor to aim such a ship in your direction.

In fact, realizing the potential weaponry power of an interstellar spacecraft might be just enough to persuade a really intelligent civilization not to build one. And so the answer to Fermi's question might be that everybody decided to stay safe at home. —*Tom Siegfried, Editor in Chief*



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Scientific Observations

"Discovery of this important correlation [of specific gene mutations with breast cancer risk] was a discovery of the handiwork of nature—the natural effect of certain mutations in a particular segment of the human genome…. The isolation of *BRCA1* and *BRCA2* DNA, while requiring technical skill and considerable labor, was simply the application of techniques well-known to those skilled in the art. The identification of the *BRCA1* and *BRCA2* gene sequences is unquestionably a valuable scientific achievement for which [the biotech company] Myriad deserves recognition, but that is not the same as concluding that it is something for which they are entitled to a patent."

—U.S. DISTRICT COURT JUDGE ROBERT SWEET IN A MARCH 29 RULING STRIKING DOWN CERTAIN PATENTS ON GENES RELATED TO BREAST AND OVARIAN CANCERS

Science Past | FROM THE ISSUE OF APRIL 23, 1960

MEAT FLAVOR ISOLATED; MAY MAKE ALGAE EDIBLE — Two U.S. Department of Agriculture scientists have isolated and freeze-dried substances that give beef and pork their flavor and aroma. The substances could add flavor to the unappetizing algae that may be grown in interplanetary manned space ships as food for astronauts.... The [researchers] used cold water to extract the flavor substances and then freeze-dried the extract into a powder. When heated, the powder produced the rich aroma of roast meat. The studies showed the main meaty flavor of meats is in their lean parts. But the crucial flavor elements that give pork and beef their distinctiveness are found in the fatty portions.

Science Future

May 9–14
The 2010 Intel International Science and Engineering Fair is held in San Jose, Calif. See www.societyforscience.org/isef

June 3–4
Researchers meet in Chicago to discuss social factors affecting mental health. See www.adler.edu/news/events

June 14–17
Mathematicians meet in Austin, Texas, to assess progress in discrete mathematics. See www.siam.org/meetings/dm10

SN Online

www.sciencenews.org

DELETED SCENES BLOG
Researchers follow up on a study showing how the brains of a drug addict and a junk food addict aren't all that different. Read "Junk food junkies, round two."

LIFE
A hyena's laughter may convey a serious message about status among peers. See "When two hyenas get the giggles" for story and audio clips.

MATTER & ENERGY
It's not a party trick. Physicists have created conditions in which hot water freezes faster than cold. Read "You really can freeze hot water faster than cold."

EARTH
Tyrannosaurs roamed Down Under, fossils show. See "Tyrannosaurs lived in the southern hemisphere, too."

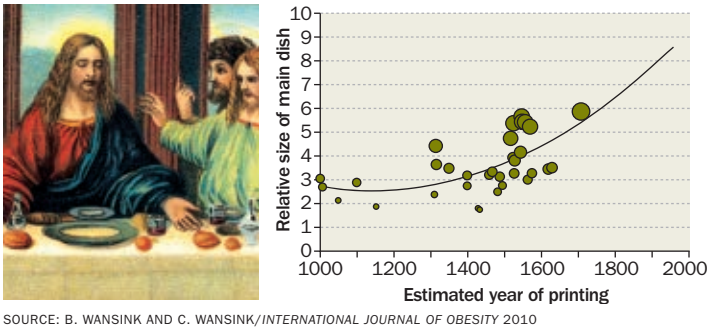
For Daily Use

Bottling up anger isn't always a good thing, but physically putting away a symbol of it just might be. An international team of researchers tested this idea by asking study participants to write down a memory of a bad decision they had made. Half the participants handed their notes to an experimenter and the other half put the descriptions in an envelope before turning them in. Participants then noted how they felt about the decision at that moment. Those who had sealed their memory away felt less negatively than those who handed the paper directly to the experimenter, researchers report in an upcoming *Psychological Science*.

Science Stats | SIZING UP THE *LAST SUPPER*

Over centuries, dish size in *Last Supper* paintings grew relative to head size in the art. This may have reflected growing meal portions in society, researchers argue.

Average main dish size relative to average head size in *Last Supper* pieces



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CLOCKWISE FROM TOP LEFT: U.S. FEDERAL COURTS, WIKIMEDIA COMMONS; ELI. M. SWANSON/MICHIGAN STATE UNIVERSITY; BETTMANN/CORBIS

“ Islands are clearly these crucibles of evolution. ” — **DANIEL RUBINOFF, PAGE 8**

Life The way that pachyderms walk

Body & Brain Not so identical gut microbes

Atom & Cosmos Smashing success at LHC

Earth Ocean coverage kept Earth warm

Molecules Benefits of a dark roast

Technology ID tag to replace bar codes

Matter & Energy Gold dust spectroscopy

Genes & Cells Bee gene drives food choice

In the News

STORY ONE

Recovered DNA suggests a new type of hominid

Stone Age relative may have lived among modern humans

By Bruce Bower

A new member of the human evolutionary family has been proposed for the first time based on an ancient genetic sequence, not fossil bones. Even more surprising, this mysterious hominid, if confirmed, would have lived near Stone Age Neandertals and *Homo sapiens*.

“It was a shock to find DNA from a new type of ancestor that has not been on our radar screens,” says geneticist Svante Pääbo of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany.

Researchers led by Pääbo and Max Planck graduate student Johannes Krause propose the new hominid based on DNA from a finger bone, found in the Altai Mountains of central Asia, that dates to between about 48,000 and 30,000 years ago. The DNA suggests the hominid left Africa in a previously unsuspected migration around 1 million years ago, the team reports online March 24 in *Nature*.

Paleoanthropologists have generally assumed that hominids left Africa in a few discrete waves, starting with *Homo erectus* about 1.9 million years ago. (In the April 9 *Science*, researchers introduce a new hominid species, *Australopithecus sediba*, that they argue was ancestral to *Homo erectus*. But other scientists are highly skeptical of the new species’ relationship to the *Homo* genus.)

General consensus holds that Neandertal ancestors, known as *H. heidelbergensis*, left Africa between 500,000 and 300,000 years ago, followed by humans around 50,000 years ago. But the new genetic sequence supports a scenario in which at least one additional and possibly many more African hominid lineages trekked to Asia and Europe in the wake of *H. erectus*, Pääbo says.

The finger bone that provided the curious sequence was unearthed in 2008 at Denisova Cave in southern Siberia’s Altai Mountains. Previous excavations of stone and bone artifacts in the cave have indicated that Neandertals and modern humans lived there periodically beginning at least 125,000 years ago, but few fossils have turned up at the site.

While analyzing DNA from the presumed Neandertal fossils in November 2009, Krause noticed an unusual mitochondrial sequence. Mitochondrial DNA is located outside the cell nucleus and is inherited from the mother.

Krause conducted tests to confirm that the recovered mitochondrial DNA came from an ancient hominid rather than from bacteria or researchers who had handled the fossil. Using advanced techniques for fishing DNA fragments out of fossils, the team then assembled

Another hominid, dubbed “X woman,” may need to be added to the list of species (see map) outside of Africa for which there is fossil or genetic evidence.

REDMAL/ISTOCKPHOTO, ADAPTED BY A. NANDY

For today's top stories, visit SN Today at **www.sciencenews.org**

a complete mitochondrial genome for the Denisova individual. The same approach has yielded DNA sequences for Neandertals (*SN: 3/14/09, p. 5*) and a Greenlander who lived 4,000 years ago (*SN: 3/13/10, p. 5*).

The researchers compared Denisova mitochondrial DNA with complete mitochondrial sequences from 54 people who are living today as well as a human who lived in Siberia about 30,000 years ago, six Neandertals that lived more than 40,000 years ago, a modern pygmy chimpanzee and a modern common chimp.

Mitochondrial DNA from the Denisova fossil differs from that of humans at almost twice as many chemical positions as Neandertal mitochondrial DNA does, Krause says.

"That number of differences is good evidence for a new hominid because simple variation can't account for it," remarks geneticist Morten Rasmussen of the University of Copenhagen.

Assuming that maternal ancestors of humans and chimps diverged 6 million years ago, the researchers calculate that a maternal ancestor common to the Denisova hominid, Neandertals and modern humans lived between 780,000 and 1.3 million years ago. A common maternal ancestor of modern humans and Neandertals lived more recently, an estimated 320,000 to 620,000 years ago.

Excavations in the Altai Mountains of Siberia have unearthed a number of artifacts attributed to early humans.

Krause and Pääbo are now directing an effort to extract nuclear DNA from the Denisova fossil. Comparisons of Denisova, Neandertal and modern human nuclear DNA are needed to determine whether this new type of hominid is a separate species and to check for signs of interbreeding with Neandertals or humans.

For now, the researchers refer to the Denisova hominid as "X woman," although its sex remains undetermined until nuclear DNA can be examined.

"What we can say for now is that there were at least three different forms of hominids living in the Altai Mountains around 40,000 years ago," Pääbo says. At that same time, some argue, a fourth species named *Homo floresiensis*, better known as hobbits, occupied the Indonesian island of Flores (*SN: 5/10/08, p. 7*).

In a comment published with the new report, geneticist Terence Brown of the University of Manchester in England says that further ancient DNA studies will "possibly increase the crowd of ancestors that early modern humans met when they traveled into Eurasia."

Anthropologist Ian Tattersall of the American Museum of Natural History in New York City agrees. Hominid evolution over the past 6 million to 7 million years includes at least two dozen species, in his view. It was "practically routine" for species to live in the same area at the same time, he says.

In contrast, anthropologist Erik Trinkaus of Washington University in St. Louis views the new genetic data with skepticism. "I don't know what to make of this, at least not until there is more substantial fossil material than a partial finger bone," he says. "It may be going too far to propose a new hominid."

Trinkaus, who sees fewer hominid species than Tattersall, cautions that biologists have trouble identifying different species even among living primates.

Back Story | WHO'S WHO IN THE GENUS *HOMO*

Scientists think the *Homo* genus evolved 2.3 million years ago. The discovery of 1.7-million-year-old skulls in Georgia, though, has caused confusion about the genus's direct ancestor and relationships among *Homo* species.

H. erectus
Bones of 50-plus *H. erectus* individuals dating from 300,000 to 800,000 years ago have been found at sites in Java and China.

H. heidelbergensis
Evidence for this species, dating to at least 350,000 years ago, comes from across Europe. Most believe it is an ancestor of Neandertals.

H. floresiensis
A partial skeleton and other bones found on Flores have led some scientists to propose this species. It may have lived until just 17,000 years ago.

H. neanderthalensis
After their ancestors left Africa, Neandertals spread across Europe, the Middle East and into Siberia before going extinct 30,000 years ago.

H. sapiens
Modern humans are the only living members of the *Homo* genus. They may have lived near other hominids 40,000 years ago.

TOP: J. KRAUSE; BACK STORY: *H. FLORESIENSIS*: MAURICIO ANTON/PHOTO RESEARCHERS, INC.; ALL OTHERS: MAURICE WILSON/©THE NATURAL HISTORY MUSEUM, LONDON

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Life

To see a video of an elephant on the move, visit **www.sciencenews.org/elephant_gait**

Elephant legs bend like human legs

Limbs act as levers to propel animals forward, study shows

By Lisa Grossman

Elephants cruise on four-wheel drive and bendy knees using a gait different from most quadrupeds, a new study shows.

Whereas most four-legged animals use their front legs to stop and their back legs to go, elephants split the work evenly among all their legs. "There's no obvious division of labor," says study coauthor Lei Ren of the University of Manchester in England. All four legs "work together to achieve the same goals."

Also, contrary to long-held belief, elephants' legs are not stiff columns. Their joints allow more flex than horses' do, and are almost exactly as bendy as human legs. The new work was published online March 29 in the *Proceedings of the National Academy of Sciences*.

A 4-ton elephant named Tantawan crosses a force platform while cameras capture her movements.

Earlier studies had found that the bigger and heavier an animal, the stiffer its legs. Ren and his colleagues studied six Asian elephants to see whether they stand and walk with their legs straight or bent. Pillarlike legs mean less work for muscles supporting the animal's mass, says coauthor John Hutchinson of the Royal Veterinary College in Hatfield, England.

The researchers worked with Richard Lair and expert elephant handlers at the Thai Elephant Conservation Center in Lampang, Thailand, to install 16 custom-made force platforms in the ground. The team placed reflective disks at key points on the elephants' bodies and used seven infrared cameras to record the elephants' movements as they walked or ran over the scales.

The experiments are a technical step forward, says Herman Pontzer of Washington University in St. Louis. "It's always neat to see this stuff done with elephants, because it's so hard to do the work."

Combining data from the cameras and the force platforms allowed the scientists to compute how hard elephants' muscles must work during locomotion. The group found that the muscles provide only one-third the force that earlier models had predicted, indicating that elephants' legs must be limber enough to act as levers to propel the animals forward.

Like humans, elephants also tend to work their muscles harder when shifting from walking to running, the team shows.

Caterpillars hang loose—wet or dry

Moths evolved amphibious life stage in Hawaiian Islands

By Susan Milius

They don't surf, but caterpillars found in Hawaii are the first insects known to feed and grow as readily in water as on land.

Other land insects can endure a dunking. And other aquatic ones can survive a dry spell out of water. But larvae in 12 newly found species in the moth genus *Hyposmocoma* can thrive both underwater in rushing streams and exposed to air on rocks poking out of the water, says evolutionary biologist Daniel Rubinoff of the University of Hawaii at Manoa.

Hyposmocoma moths live only in the Hawaiian Islands. Most species in the genus spend caterpillarhood exclusively on land before flitting away as full-grown moths. Yet genetic analyses show that at least three times within the genus, landlubber lineages have independently evolved amphibious caterpillars, Rubinoff and University of Hawaii colleague Patrick Schmitz report online March 22 in the *Proceedings of the National Academy of Sciences*.

Besides introducing some remarkable caterpillars, the work highlights how islands influence evolution. Isolated mixes of the relatively few kinds of creatures that arrive on islands can come up with novelties unknown elsewhere. "Islands are clearly these crucibles of evolution," Rubinoff says.

A Hawaiian caterpillar uses a tether to hold on to a rock in a fast-flowing stream.

The researchers discovered the wet-dry caterpillars grazing on rocks in streams, seemingly unfazed by changes in the water level. In lab studies, the team showed that the caterpillars don't have gills or a way of trapping air bubbles. Instead, they appear to have another way to get oxygen directly from the water. To survive submerged, the caterpillars need fast-flowing water. They shelter on the downstream sides of rocks and spin silken tethers to keep from washing away.

"Interesting, fun and really quite significant," Steve Jordan of Bucknell University in Lewisburg, Pa., says of the new work.

FROM TOP: J.R. HUTCHINSON; RUBINOFF LAB

Body & Brain

5 per 100,000 Prevalence of MS in Nigeria

15 per 100,000 Prevalence of MS in Tunisia

100 per 100,000 Prevalence of MS in Sweden

Sunlight may cut MS risk by itself

Study complicates theories about the role of vitamin D

By Nathan Seppa

Ultraviolet radiation from the sun seems to thwart multiple sclerosis, but perhaps not the way most researchers had assumed, a new study in mice suggests.

If validated in further research, the finding could add a twist to a hypothesis that has gained credence in recent decades. The report appeared online March 22 in the *Proceedings of the National Academy of Sciences*.

Scientists have observed that MS is rare in the tropics and more common at high latitudes, presumably because people living nearer the equator synthesize more vitamin D thanks to more sun exposure.

But a direct cause-and-effect relationship between vitamin D deficiency and MS has never been established. In recent mouse experiments, biochemist Hector DeLuca and his team at the University of Wisconsin–Madison tested the link between vitamin D and MS risk and came away unconvinced.

In MS, the immune system attacks fatty myelin sheaths that insulate nerves. DeLuca and his team induced a condition comparable to human MS in mice by injecting the animals with proteins that instigate similar myelin damage.

> "We concluded that UV light is doing something beyond" making vitamin D.
>
> HECTOR DELUCA

The researchers exposed some mice to UV light before and after giving the animals the damaging injection. Another group of mice got the injection but not the UV exposure.

The mice exposed to UV suppressed the MS-like disease better than the control mice, the researchers found, even though the UV radiation dose wasn't enough to greatly increase the animals' blood concentrations of vitamin D.

In another test, the scientists gave the mice varying doses of vitamin D supplements, but did not expose the animals to UV light. At safe doses, the supplements failed to control the disease.

"We concluded that UV light is doing something beyond" making vitamin D, DeLuca says.

Multiple sclerosis risk might well be influenced by a biological mechanism apart from vitamin D blood levels, but many questions remain, including how UV radiation might inhibit the immune system and the development of the disease, says George Ebers, a neurologist at the University of Oxford in England.

Identical twins differ at gut level

Intestinal microbes vary widely, perhaps influenced by diet

By Laura Sanders

Twins may share appearances, mannerisms, even clothes — but the microbes in their intestines are far from the same. By cataloging microbial genes in the gut, researchers have found that communities of bacteria can differ dramatically even between identical twins.

The findings, which appeared online April 2 in the *Proceedings of the National Academy of Sciences*, give scientists a deeper understanding of what makes one person's intestinal menagerie different from another's.

Working out what's behind the composition and function of a person's gut bacteria is "a very important problem," says microbiologist Frederic Bushman of the University of Pennsylvania School of Medicine in Philadelphia. Intestinal bacteria spur digestion, manufacture vitamins and keep people healthy; changes in the bugs have been linked to irritable bowel syndrome and metabolic disorders. Because of their role in processing the nutrients from food, gut bacteria may even influence body weight.

In the new study, researchers comprehensively sequenced bacterial genes in stool samples from a pair of identical twins, 26-year-old women from Missouri. Since identical twins have nearly identical DNA, any differences between their gut microbial populations would have to be due to nongenetic factors such as diet, disease history or exposure to antibiotics.

"Diet is probably a huge, huge factor," says study coauthor Jeffrey Gordon, a systems biologist at Washington University School of Medicine in St. Louis.

Only about 17 percent of DNA sequences in the twins' gut microbes overlapped, based on a classification scheme developed by the researchers. What's more, about 64 percent of the gene groups identified had not been seen in previous studies.

One of the notable differences between the twins was a gene group that produces proteins in a family called dockerins, which form assemblies that microbes use to break down cellulose. Only one twin's intestinal bacteria possessed these genes.

In addition to looking for which genes were present in the gut microbiomes, the team went a step further and determined which ones were active. Some microbial genes found in both twins showed similar levels of activity, but the researchers found differences, too.

"This is the first look at the repertoire of expressed genes," Gordon says. The results provide a baseline for understanding how gut microbe genes function differently in different people. ■

Atom & Cosmos

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LHC smashes high-energy record

World's largest collider collects first data from 3.5 TeV beams

By Laura Sanders

By all accounts, the Large Hadron Collider's record-setting day of proton bashing was a smashing success. The powerful machine at CERN, Europe's high-energy physics lab near Geneva, got off to a rocky start on March 30. But by early afternoon (Geneva time), two 3.5-trillion-electron-volt beams were colliding head-on.

The collisions in the 27-kilometer-around accelerator set a new record for highest-energy particle crashing.

"Today, we opened the door and put our nose through it," says Jürgen Schukraft, a physicist with CERN's ALICE experiment, which will explore new types of matter produced in the collisions.

Researchers began circulating beams at 3.5 TeV on March 19, but had not yet collided them. Around 1 p.m. local time on March 30, CERN tweeted "Experiments have seen collisions!!!!!!!!!!!" followed quickly by "First time in the history!!!!!!!!!!! World record!!!!!!!!"

Experiments recorded data for more than three hours before ramping down for the day.

"Already it looks like we are entering new territory," Schukraft says. But it will take "years, not days or weeks," he adds, to answer physicists' questions about theoretical predictions like the elusive Higgs particle, dark matter and supersymmetry.

A morning collision attempt was aborted when a piece of overly sensitive equipment detected errant electromagnetic radiation. Scientists resolved the issue, and by early afternoon, "it was all OK," Schukraft says. "It works perfectly."

CERN plans to run the accelerator at 3.5 TeV per beam for the next 18 months to two years, with a brief maintenance break at the end of 2010. Then the LHC will be shut down and prepared to run at its maximum energy of 7 TeV per beam.

Forming cosmic magnetic fields

Gamma-ray data from blazars favor 'top-down' hypothesis

By Alexandra Witze

Astronomers have detected evidence of how strong the magnetic fields between galaxies must be. The finding illuminates how magnetism arose in the cosmos and could one day serve as a probe for understanding processes that happened soon after the Big Bang, 13.7 billion years ago.

The study, published online April 1 in *Science*, "may be a clue that there was some fundamental process in the intergalactic medium that made magnetic fields," says Ellen Zweibel, an astrophysicist at the University of Wisconsin–Madison, who was not associated with the work.

All galaxies contain magnetic fields; the Milky Way's field is most intense near its center, where its strength is about 1/10,000th of Earth's. Magnetic fields also permeate intergalactic space, but until now astronomers haven't known how strong those fields are or how they arose.

One "top-down" idea is that all of space was imbued with a slight magnetic field soon after the Big Bang, and this field grew in strength as stars and galaxies amassed. A "bottom-up" possibility is that magnetic fields formed first by the motion of plasma in small objects, such as stars, and then propagated outward into space. The new work suggests that the top-down option is right and puts a lower limit on the intensity of the fields.

Andrii Neronov and Ievgen Vovk, of the Geneva Observatory, reached this conclusion by studying blazars, the bright hearts of active galaxies that spew jets of energized particles toward Earth. The orbiting Fermi Gamma-ray Space Telescope has spotted a number of these objects.

Blazars, active galactic nuclei that beam near–light-speed particles at Earth, offer clues to magnetic fields in space.

GODDARD SPACE FLIGHT CENTER/NASA

But blazars are more than cosmic beauties; they also provide information about the space the gamma rays have traversed. Gamma-ray photons are electrically neutral and so zoom through empty space unperturbed by magnetic fields. But occasionally a gamma ray will collide with another photon of much lower energy, generating an electron and a positron. Because those two new particles are charged, they are subject to deflection by a magnetic field. They later recombine to form a gamma ray again, which proceeds unharmed, but with a lower intensity.

Neronov's team looked at Fermi data for gamma rays with the intensity expected if they hadn't been converted into charged particles and then deflected by magnetic fields. The researchers spotted no such rays. That lack of detection, says Neronov, "tells us that electrons and positrons were deflected. There is nothing else to deflect them but a magnetic field."

That means magnetic fields must exist in intergalactic space with a strength of at least one ten-million-billionth the strength of Earth's. That lower bound suggests that "there really was some process that acted on very wide scales throughout the universe," Zweibel says.

Earth

3 percent Proportion of Earth covered by land 3.8 billion years ago

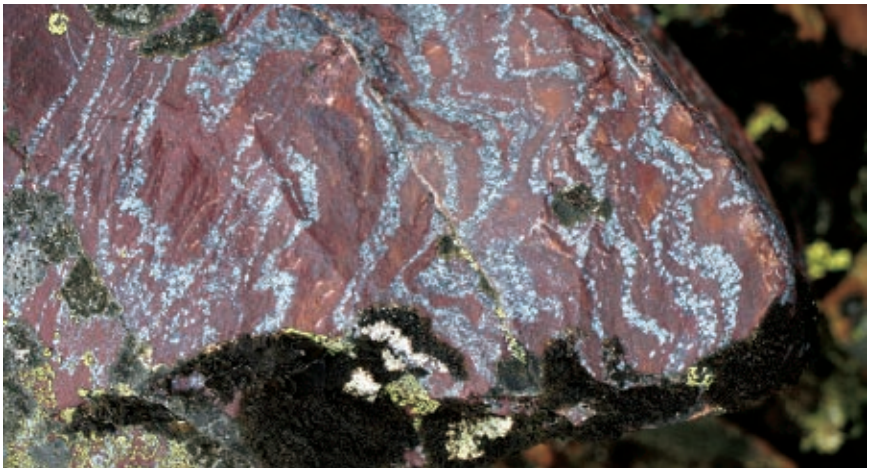
17 percent Earth's land cover 2.4 billion years ago

29 percent Earth's land cover today

Dark ocean kept early Earth warm under a faint sun

Greater light absorption may have been planet's antifreeze

By Sid Perkins



Analyses of banded iron formations, such as this outcrop in Greenland, indicate that greenhouse gas levels were too low to explain Earth's warmth billions of years ago.

M. ROSING

Though the sun was so dim billions of years ago that the young Earth should have been literally freezing, the planet remained largely covered with liquid water. That was thanks to a substantially darker surface and a dearth of light-scattering clouds, a new study suggests.

"All other things being equal, Earth should have been frozen over for the first half of its existence," says James F. Kasting, a geoscientist at Pennsylvania State University in University Park who was not involved in the research. "But it wasn't."

Previously scientists have explained the presence of liquid water in that low-light time, during the Archean Eon (about 3.8 billion to 2.5 billion years ago), by suggesting that Earth's atmosphere held large amounts of planet-warming greenhouse gases such as carbon dioxide and methane. But new analyses show that greenhouse gases weren't high enough to explain the warmth, a team of earth scientists reports in the April 1 *Nature*.

The researchers now propose that the early Earth stayed above freezing because the planet was darker and therefore absorbed more of the sun's energy — the same phenomenon that renders dark vinyl car seats scorching hot while light-colored seats stay relatively cool.

Early in the sun's lifetime, the portion of the solar core where light- and heat-generating fusion reactions take place was much smaller than it is today. So, for an extended period, the sun could have been up to 30 percent dimmer than it is now, says Minik Rosing, a geologist at the University of Copenhagen's Nordic Center for Earth Evolution. Although Earth's surface temperature should have been well below freezing, geological signs of liquid water in that era abound — a puzzler that scientists have dubbed the "faint young sun paradox."

Some studies have suggested that carbon dioxide concentrations in Earth's early atmosphere were more than 100 times current levels. But the new analyses of ancient rocks known as banded iron formations (*SN: 6/20/09, p. 24*) reveal proportions of iron-bearing minerals that could appear only if carbon dioxide levels were no more than three times modern values — a concentration too low to keep the planet from freezing beneath a faint young sun.

Methane probably didn't help make up the difference, Rosing adds, because at high concentrations methane reacts chemically to form a light-scattering haze that would have cooled Earth's surface rather than warming it.

What probably kept Earth above freezing during the dim-sun era was its darker surface, Rosing and his colleagues contend. The continents were much smaller then, so the planet's oceans — which are typically much darker than landmasses — could absorb more heat. About 3.8 billion years ago, continents covered less than 5 percent of Earth's surface, a proportion that gradually approached today's value of 29 percent around 1.5 billion years ago.

Second, the researchers suggest, light-scattering clouds covered much less of Earth's surface long ago — another net gain for surface warmth. Because early Earth lacked plants and other complex life, the biologically produced particles and chemicals that water droplets coalesce around weren't available. In the few clouds that did form, droplets were larger and scattered light less efficiently, allowing more warming radiation to reach ground level.

In their paper, the researchers present a numerical simulation that shows how these two rather straightforward phenomena could have kept Earth's average temperature above freezing.

"A lot of the reviewers of our paper were kicking themselves and asking, 'Why didn't we think of this first?' " Rosing says.

Despite the new findings, the faint young sun problem may not be fully solved, Kasting says. For one thing, the new analyses don't consider effects of high-latitude ice masses on the planet's albedo, or reflectivity. "We clearly need additional constraints to understand why the Archean Earth remained habitable," he writes in the same issue of *Nature*. ■

Molecules

For longer versions of these and other chemistry meeting stories, visit **www.sciencenews.org/acs_march2010**

Newer chemicals found in wildlife

Supposedly safer flame retardants turning up in falcon eggs

By Rachel Ehrenberg

Two chemicals that are replacing potentially toxic flame retardants in products such as TVs and furniture have shown up in peregrine falcon eggs in California.

While the replacement compounds were found in much smaller quantities than the older generation of flame retardants, their presence in bird eggs is cause for concern, said June-Soo Park of the California Environmental Protection Agency in Berkeley. Little is known about the toxicity of the replacements and their potential to accumulate in people and wildlife, said Park, who presented the new research March 25.

The eggs of peregrine falcons have been found to contain flame retardants from household items.

Fire retardants of the earlier generation, known as polybrominated diphenyl ethers, or PBDEs, were added to household products such as furniture, electronics and carpeting to reduce fire-related injuries. "We don't want kids' pajamas catching on fire," said Sarah Rubinfeld of Stanford University.

In California, which has especially stringent product flammability laws, people and wildlife contain some of the highest PBDE levels in the world, Park noted. Research on animals suggests that many PBDEs mimic the effects of thyroid hormones, meddling with reproduction and nerve and tissue development. Two of the most common formulations have been banned in California since 2006.

But researchers are still finding PBDEs in the environment, where their replacements — hexabromobenzene, known as HBB, and Bis(2,4,6,-tribromophenoxy) ethane, known as BTBPE — are also now showing up.

Park's team has been studying peregrine falcons, which were endangered by pesticides such as DDT but have recovered in much of the United States. These predatory birds are considered sentinels of environmental health.

Park and his colleagues measured levels of contaminants in eggs and chicks from 38 nest sites between 1986 and 2007. In the eggs, PBDE levels more than tripled each decade, Park noted.

Data suggest that the new flame retardants are also accumulating in wildlife, Park reported. The research team detected HBB and BTBPE in 19 falcon eggs, but at much lower quantities than the old standby chemicals. It isn't clear how the falcons accumulate the new flame retardants, Park said. Other scientists have reported finding HBB in herring gulls around the Great Lakes and BTBPE in dust samples from bedrooms and living rooms in the Boston area.

The replacement flame retardants are considered safer because they don't break down as readily into absorbable forms, but the flip side is that they may persist for a long time.

Cap it or cork it, but let it breathe

Cork is not necessarily better for wine than a screw-on cap

By Rachel Ehrenberg

In a taste test with pinot noir and chardonnay, consumers couldn't discern whether wines had been capped with natural corks or screw caps, scientists reported March 25.

"Wine quality should really be judged by the wine, not the cork," said study coauthor Michael Qian of Oregon State University in Corvallis. "The right kind of screw cap is just as good as a cork, or even better, because it is more consistent."

The permeability of a wine's cork determines the amount of oxygen that enters the wine, and this acts on compounds that affect flavor. Some traditionalists assert that real corks are the only way to get the healthy gas exchange needed for a flavorful wine, while screw caps are suffocating.

Qian and colleagues tested 2006 vintages from the Argyle Winery in Oregon. The winery closed 150 bottles each with natural cork, synthetic cork and three screw caps, each with a different lining. Every six months for two years the team tested the chemical profile and dissolved oxygen content of the wine under each type of seal. The synthetic cork and the cap lined with low-density polyethylene let in more oxygen than the natural cork, running the risk that too many flavorful compounds such as thiols and esters would be oxidized. Screw caps made from a polyvinylidene chloride–tin foil combination let in the least oxygen. A cap lined with polyvinylidene chloride–polyethylene mix had chemical and taste profiles similar to the traditional cork, said Qian.

Sai Prakash Chaturvedula, a chemist with the Coca-Cola Company in Atlanta, says he'd like to see how other compounds in wine, such as polyphenols, are affected by the different caps.

AVICEDA/WIKIMEDIA COMMONS

75 milligrams | Caffeine in one shot of Starbucks espresso

260 milligrams | Caffeine in a 12-ounce Starbucks coffee

MEETING NOTES

Darker coffee, less stomach acid

Roasting coffee beans doesn't just impart bold, rich flavor. It also creates a compound that helps dial down production of stomach acid, according to research presented on March 21.

Veronika Somoza of the University of Vienna and her colleagues extracted compounds, including caffeine and N-methylpyridinium, a ringed compound not found in green coffee beans but created in the roasting process, from regular commercial coffee blends.

Dark roasted coffee had more than 30 milligrams per liter of NMP compared with 22 mg/l in the lighter roasts. Human stomach cells treated with coffee that had medium or high concentrations of NMP secreted far less acid than cells treated with coffee containing the least amount of NMP. And the activity of many of the genes and proteins involved in this gastric secretion were quashed in cells exposed to NMP-rich coffee.

"Our idea is to identify these beneficial compounds and enhance them," Somoza says. —*Rachel Ehrenberg*

Walnuts may slow prostate cancer

Prostate tumors grew more slowly in mice fed a diet rich in walnuts, Paul Davis of the University of California, Davis reported March 22.

Previous work has shown that walnuts can benefit the heart by fighting inflammation and allowing blood vessels to dilate. Davis notes that inflammation also plays a role in many cancers, and that walnuts can tinker with production of endothelin, a protein that helps regulate prostate growth.

To study how walnuts affect prostate cancer, Davis and his colleagues studied mice genetically programmed to develop the disease. When the animals are fed a normal quantity of fat for mice—5 percent of calories—the tumors grow slowly. But bump dietary fat up to a whopping 20 percent of calories and tumor growth mushrooms, Davis reported—except if that 20 percent of fat calories comes from walnuts. Cancer in those mice grew slowly, similar to the rate seen in animals downing a low-fat diet. A man would have to consume about 500 calories' worth of walnuts to equal what the mice ate, Davis says. —*Janet Raloff* ■

Technology

"No more lines. You just walk out with your stuff." —JAMES M. TOUR

Bar codes may check out next

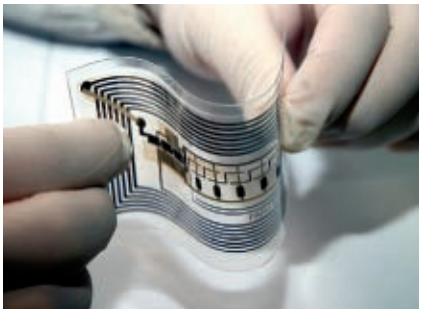
Printed RFID tags could be passively scanned from afar

By Lisa Grossman

Grocery checkout lines might become as obsolete as milkmen if a new tag meant to replace bar codes becomes common.

Researchers from Sunchon National University in Suncheon, South Korea, and Rice University in Houston have built a radio frequency identification tag that can be printed directly on cereal boxes and potato chip bags. The ink itself would broadcast information about each item in a grocery cart.

"You could run your cart by a detector and it tells you instantly what's in the cart," says James M. Tour of Rice University, whose research group invented the ink. "No more lines. You just walk out with your stuff."



Putting printable radio frequency identification devices in packaging could take the wait out of grocery shopping.

RFID tags are already used in passports, library books and gadgets that let drivers pay tolls without stopping. But those tags are made from silicon, which is more expensive than paper and has to be stuck onto the product as a second step.

The new tag, reported in the March *IEEE Transactions on Electron Devices*, costs about three cents compared with about 50 cents for each silicon-based tag. The team hopes to bring that cost below one cent per tag to make the devices commercially competitive.

"The work is impressive," comments Thomas N. Jackson of Pennsylvania State University in University Park, who is also developing flexible electronics.

So far, the tag can store a single bit of information — basically a 1 or a 0 — in an area about the size of a business card. That's not much data compared with a computer chip, but study coauthor Gyoujin Cho of Sunchon National University is working with a team from the Printed Electronics Research Center of the Paru Corp. in Suncheon to squeeze 96 bits onto a 3-square-centimeter tag. That would be enough to give a unique identification code to each item in a supermarket, along with information like how long the item has been on the shelf, Tour says.

Precious metals belong in jewelry

Perovskite outdoes platinum in cleansing diesel exhaust

By Alexandra Witze

Chemical engineers have found a cheaper and possibly better material than platinum for cleaning up diesel exhaust.

Many automobiles use platinum-containing catalytic converters to help clean exhaust streams of pollutants, notably the nitrogen oxide compounds that can contribute to smog. But the high and volatile price of the precious metal makes it difficult to build an economical catalyst.

A material known as perovskite is far less expensive than platinum and may do the job more effectively, engineers from the research arm of General Motors report in the March 26 *Science*.

"It's excellent work, really groundbreaking to be able to have an alternative to platinum-based catalysts," says Louise Olsson, a catalysis researcher at Chalmers University of Technology in Göteborg, Sweden. "It's going to save a lot of money."

Diesel cars can cost $1,000 to $5,000 more than comparable gasoline models because of the need to modify the engine and add more expensive catalytic converters to meet emissions standards. The platinum used in many of those converters has recently traded for as much as $1,700 per troy ounce.

Catalytic converters using perovskite could make diesel vehicles cheaper.

The problem is that diesel engines need to burn "lean," or in the presence of extra air, compared with regular gasoline engines. The extra oxygen makes it harder to remove nitrogen oxides.

A team led by Wei Li at GM's Global Research and Development branch in Warren, Mich., focused on a chemical reaction in diesel exhaust streams that converts NO to NO_2, which can then be further processed and released to the atmosphere as nitrogen gas.

The researchers replaced a commercial platinum-based catalyst with one based on perovskite oxides made of cobalt or manganese combined with oxygen. By adding a bit of strontium and lanthanum into the mix, Li's team showed that the manganese-based perovskite catalysts converted NO to NO_2 about as well as platinum-based ones did.

The cobalt-based perovskite catalyzed the reaction even faster than platinum. "We were looking for a good catalyst, but we were not expecting it to be that good," says Li.

FROM TOP: G. CHO/SUNCHON NATIONAL UNIV.; W. LI

Matter & Energy

For more Matter & Energy stories, visit **www.sciencenews.org**

Number 117 joins element family

New superheavy atom fills gap in chemistry's periodic table

By Alexandra Witze

Physicists have reported synthesizing element 117, the latest achievement in their quest to create "superheavy" elements in the laboratory. A paper describing the discovery has been accepted for publication in *Physical Review Letters*.

A team led by Yuri Oganessian of the Joint Institute for Nuclear Research in Dubna, Russia, created the new element by smashing calcium-48 — an isotope with 20 protons and 28 neutrons — and berkelium-249, with 97 protons and 152 neutrons. The collisions created two isotopes of an element with 117 protons.

Sigurd Hofmann, a nuclear physicist at the GSI research center in Darmstadt, Germany, says the work is "convincing."

With rare exceptions, elements heavier than uranium, atomic number 92, must be made in the laboratory.

The Russians collaborated with U.S. researchers, including some from Oak Ridge National Laboratory in Tennessee, where the berkelium was made. Berkelium, atomic number 97, is one of the rare artificially produced elements; the Russian team was able to obtain just 22 milligrams of it from Oak Ridge.

The new element slips into a vacancy in the periodic table between previously discovered elements 116 and 118.

Researchers spotted signs of 117 during two runs of collisions lasting 70 days each. In their paper, the scientists report evidence for a heavier isotope (atomic mass 294) with an inferred radioactive decay half-life of 78 milliseconds. They calculated the half-life of the lighter isotope (atomic mass 293) at 14 milliseconds. Both lifetimes are relatively long for superheavy elements, which usually decay away almost instantly.

"These nuclei that we have made are important because they're the longest-lived superheavy elements made," says team member Joseph Hamilton of Vanderbilt University in Nashville, Tenn.

Physicists believe that some heavier elements may occupy an "island of stability" in which their atoms stick around even longer. Analysis of the lighter atoms produced by decay of the new element confirms ideas predicting the existence of such an island of stability, Oganessian's team writes in the new paper.

Hofmann says that an interesting thing about the work is the different products that result when the two element 117 isotopes decay into lighter atoms. Decay of the heavier isotope eventually produces dubnium (atomic number 105), whereas the lighter isotope decays down to roentgenium (111). Comparing the two decay chains, Hofmann says, will help researchers better understand the characteristics of superheavy elements.

Element 117 is tentatively known as ununseptium. After its existence is confirmed, it will receive a permanent name from the International Union of Pure and Applied Chemistry. Usually the name is suggested by the discoverers.

That process can take some time. In February, the IUPAC finally granted the name copernicium to element 112, which was first reported by Hofmann's group in 1996 *(SN: 3/27/10, p. 13)*. ■

'Smart dust' aids analysis method

New technique could boost Raman spectroscopy's uses

By Rachel Ehrenberg

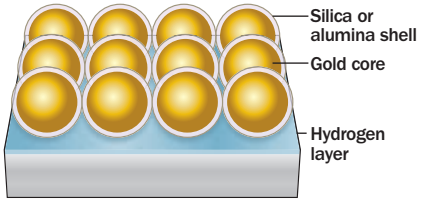
Scientists have developed a quick and dusty method for detecting trace quantities of unknown substances.

Described in the March 18 *Nature*, the new technique amounts to little more than sprinkling a layer of gold dust on the surface to be tested. Yet the method may transform an unwieldy spectroscopic tool into a more useful way to detect traces of materials such as explosives, drugs and environmental contaminants.

"This really does make the possibility of detecting things ... very, very practical," says physical chemist Martin Moskovits of the University of California, Santa Barbara, who wrote a commentary on the research in the same issue of *Nature*. The method could have broad applications, from forensics to food inspection, he says.

Jian Feng Li of Xiamen University in China and his colleagues call their method shell-isolated nanoparticle-enhanced Raman spectroscopy, or SHINERS for short. They tested it by identifying small amounts of hydrogen on a silicon wafer, probing for proteins on yeast cells and detecting insecticide on an orange peel.

The dust approach is a variation on surface-enhanced Raman spectroscopy, which shines a laser on a substance sitting on a specially prepared surface and then analyzes interactions between the laser light and the molecules in the substance.



Gold dust allows scientists to detect trace substances, in this case hydrogen.

J.F. LI *ET AL.*/*NATURE*

The new method lays this specialized surface on top of the sample in the form of a "smart dust" of gold nanoparticles coated with a thin shell of silica or alumina. When laser light strikes the particles, "hot spots" of energy are created between the particles and the sample that can be analyzed spectrographically.

Genes & Cells

For more Genes & Cells stories, visit **www.sciencenews.org**

The zebra finch, named for the stripes on the male finch's throat, is the first songbird to have its genome cataloged.

First songbird genome arrives

Zebra finch is second bird to have all of its DNA cataloged

By Tina Hesman Saey

Zebra finches have something to tweet about. The songbird's genetic instruction book has just been deciphered, scientists report in the April 1 *Nature*.

Zebra finches are the first songbird and the second bird, after the chicken, with a completely determined genome. Within the finch's DNA could be clues to how songbirds learn vocal information and use songs in social situations, providing a model for human communication.

A male zebra finch memorizes his father's song and practices singing it for a month or two. Once learned, a male's song is his signature — he sings the same tune for life. Neuroscientists have long studied the birds for insights into vocal learning.

Discovering the molecular mechanisms behind that learning could help scientists better understand human disorders such as autism and stuttering, says study coauthor David Clayton of the University of Illinois at Urbana-Champaign.

Allison Doupe of the University of California, San Francisco agrees that the new work will prove helpful: "Getting this model up to the next stage in genetics ... is good. It's great."

Activity of more than 800 genes in zebra finches' brains changes when the birds sing. That finding is in accord with previous work that showed that a large number of RNA molecules change levels when a bird listens to a song.

The new work reveals many of those RNAs as regulatory, noncoding RNAs. Levels of one, a tiny snippet of RNA known as microRNA-124, drop rapidly when a bird hears a new song. MicroRNAs are known to regulate production of proteins and have been linked to brain function (*SN: 03/01/08, p. 136*), but this is the first time a microRNA has been shown to respond to a particular thought process, Clayton says.

The new study also hints that genes encoding some proteins that help control neural communication are evolving more quickly in zebra finches than in chickens. Activity levels of some of these genes dip when zebra finches hear new songs.

Researchers also found that the immune system genes of the major histocompatibility complex are scattered across several chromosomes in zebra finches, while chickens and humans have such genes on a single chromosome.

Foraging bees go with their guts

Gene helps determine preference between nectar and pollen

By Tina Hesman Saey

When faced with a choice between carb loading and a protein-rich, Atkins-style diet, honeybees let their guts decide.

Insulin signals from fat cells in the bees' abdomens help determine whether the insects forage for high-protein pollen or sugar-filled nectar, new research shows. The study, published April 1 in *PLoS Genetics*, is the first to show how changes in insulin signals influence honeybee behavior.

Bees usually collect both nectar, a rich sugar source, and pollen, a high-protein food needed to feed bee larvae.

A honeybee's abdominal fat cells help decide whether it prefers pollen or nectar.

Reducing the activity of the *IRS* (for insulin receptor substrate) gene caused bees to forage more for pollen than for nectar, report researchers led by Gro Amdam of Arizona State University in Tempe and the Norwegian University of Life Sciences in Aas. They find that the gene, which is involved in sugar uptake by cells, regulates not just how nutrients are turned into energy but also the bees' preference for which foods to consume in the first place.

Reducing the gene's activity in fat cells affects behavior even if the gene is working normally in the brain, the group shows. That suggests the gene causes fat cells to generate a chemical signal that tells the brain what kind of food to look for.

"That's something that I find quite remarkable," says geneticist Thomas Flatt of the University of Veterinary Medicine in Vienna. "I don't think many people have considered how insulin is affecting food choices, not just what happens after food has entered the body."

Insulin is a hormone that regulates sugar intake by cells. In diabetes, insulin is missing or cells are insensitive to it, so cells don't take in the sugar they need for fuel and essentially starve to death.

Using bee strains bred to show a high or low preference for pollen, the team showed that pollen-hoarding bees have lower *IRS* activity. The researchers also reduced *IRS* activity in abdominal fat cells of bees using a technique called RNA interference. Bees that got *IRS*-inhibiting injections collected more pollen than bees given a sham injection.

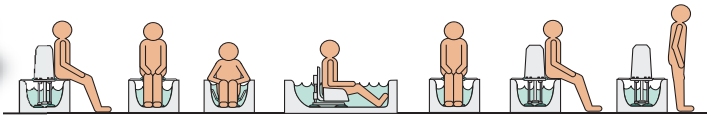
FROM TOP: L. BRIAN STAUFFER/UNIV. OF ILLINOIS NEWS BUREAU; OSMAN KAFTANOGLU

Thousands have rediscovered the luxury and therapy of bathing… now it's your turn

Exclusive offer for seniors – this newly redesigned bath lift can help you rediscover the joys and benefits of bathing.

American seniors can now enjoy the independence and dignity European seniors have for years with the newly redesigned Neptune® Bath Lift.

Smaller footprint means more room in the bath



Discover the freedom that European seniors have known for many years.
For years European seniors, long known to worship their independence and dignity, have been enjoying a quality of life in their golden years that many of us in the U.S. have not. Older Italian, English, German and French seniors have traditionally remained in their own homes and with their families significantly longer than their U.S. counterparts while relying on nursing homes and assisted living facilities far less than we do.

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A Fresh Look at Mount St.

Nearly 30 years after the peak's major eruption, recovery has just begun

Just a stone's throw north of Mount St. Helens, the oddly hummocky terrain is covered with a patchwork of vegetation and small ponds. Sediment-rich rivers thread through and meander across floodplains once hidden beneath lush, tall forests. Although harshly pruned in the recent past, the region's tree of life is beginning to sprout with vigor.

It has been nearly 30 years since the largest volcanic eruption ever observed in the lower 48 states pulverized the top of Mount St. Helens into a roiling cloud of rock and ash. A 550-square-kilometer swath of the Pacific Northwest — an area about three times the size of the District of Columbia — was almost immediately transformed from vibrant ecosystem to denuded wasteland.

In the decades since, the region has been a natural laboratory for studying the processes that bring life back in the aftermath of devastation. Ecological recovery has proceeded more quickly than many scientists thought possible, but has nevertheless been a slow and halting affair.

Ecologists have been especially struck by how important the time and season of the eruption — a roughly nine-hour episode that began a little after 8:32 a.m. on May 18, 1980 — has influenced the mountain's ecological rebound. The severely winnowed mix of flora and fauna living in the shadow of the peak today has been largely determined by what survived that mid-spring morning, ecologists note. The region's ecosystems may not resemble those in place before the eruption for a couple of centuries.

A cataclysm commences

When most people think of a volcanic eruption, they think of a mountain blowing its top. But on that spring morning, Mount St. Helens — the youngest and most active major volcano in the Cascades — blew its side. It was not a simple eruption but a concatenation of ruinous events that utterly transformed the landscape.

The peak itself was profoundly changed. Mount St. Helens had been 2,950 meters (9,677 feet) tall, snowcapped and beautifully symmetric — so much so that the dormant volcano was often called America's Mount Fuji, a reference to Japan's tallest and most revered peak. That all changed when the eruption trimmed about 400 meters off the summit of Mount St. Helens and left a 1.5-kilometer–wide, amphitheater-shaped crater.

The peak's former symmetry stemmed from its geological youth, says Michael A. Clynne, a geologist with the U.S. Geological Survey in Menlo Park, Calif. Most material in the volcano's facade had erupted during the last 3,900 years, so the forces of erosion hadn't had much time to sculpt the flanks of the peak.

"Mount St. Helens is the baby volcano of the Cascades," says Scott F. Burns, a geologist at Portland State University in Oregon.

Like many youngsters, the mountain has frequent and erratic outbursts. Dozens of eruptions have occurred in distinct clusters over the past 45,000

MAJOR/USGS

Helens

By Sid Perkins

years, separated by lulls that last anywhere from about 2,000 to 8,000 years.

"This is clearly the most active of the major Cascade volcanoes; there's no doubt about that," says Clynne.

Most eruptions, he notes, are mild affairs more akin to the one that began in 2004, when molten rock oozed into the crater floor to heighten the lava dome that's rebuilding the peak.

But every once in a while, Mount St. Helens blows itself sky high.

The 1980 eruption started with a rumble, when a magnitude 5.1 quake deep inside the volcano triggered the largest landslide ever witnessed. About 2.5 cubic kilometers of the peak's northern flank — a snow-dappled slope that for weeks had been bulging outward a couple of meters more each day — sloughed away and raced downhill at speeds that may have exceeded 200 kilometers per hour.

The sudden release of pressure was like uncorking a bottle of champagne. The blast of hot, stone-filled wind that surged northward over the rugged, forested terrain destroyed or damaged enough timber to build 150,000 wood-frame homes. The rock mixed with and melted snow and ice that had been carried from the peak, creating debris flows called lahars with the consistency of wet cement. As these lahars swept down rivers and streams, they scoured the sinuous, treelined waterways into straight-channeled, lifeless and sediment-choked torrents.

Material carried by the largest of these lahars, which flowed into the North Fork Toutle River valley just north of the volcano, buried a 60-square-kilometer area to an average depth of 45 meters and disrupted drainage patterns throughout the watershed. Heat from the volcanic ash in that freshly deposited blanket — a landscape that some scientists call "the pumice plain" — vaporized groundwater in the underlying soil, triggering blowouts of steam that excavated craters up to 400 meters across.

Life returns

Some researchers feared the area north of the volcano would remain a sterile moonscape for decades. But scientists studying the blast-seared zone north of the peak found vegetation on the landslide within a few years, says Peter Frenzen, a U.S. Forest Service biologist at the Mount St. Helens National Volcanic Monument.

Nine years after the eruption, plants had returned to just over 10 percent of the hummocky terrain. Twenty years on, vegetation had expanded to cover about two-thirds of the deposit. Today, Frenzen says, about 80 percent of the once sterile area sports vegetation.

Some of the first plants to return were lupines, most of which are perennial plants that add nitrogen to the soil. Because that nutrient and many others aren't present in volcanic ash, such nitrogen fixers form the vanguard for species that can't produce nitrogen and can't get it via symbiosis with creatures that can. Field studies done 20 years after the eruption dramatically make the point: In areas where lupines thrived, the amount of organic material in the soil and in subterranean microbes was about four times that found in areas without lupines, Frenzen notes.

Nitrogen-fixing tree species like red alder (*Alnus rubra*) still predominate on the landslide debris. Dense thickets of this fast-growing species have sprouted

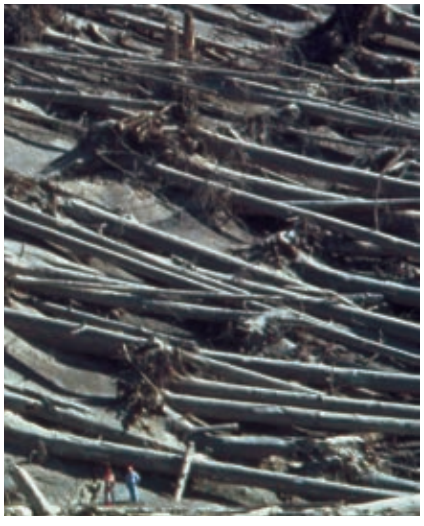
Today about 80 percent of the landslide debris north of Mount St. Helens (upper left) is covered with vegetation. Four years after the eruption, weedy perennials on high-altitude ridges that were covered by snow when the blast occurred, such as this fireweed (*Epilobium angustifolium*), were vanguards of recovery.

L. TOPINKA/USGS

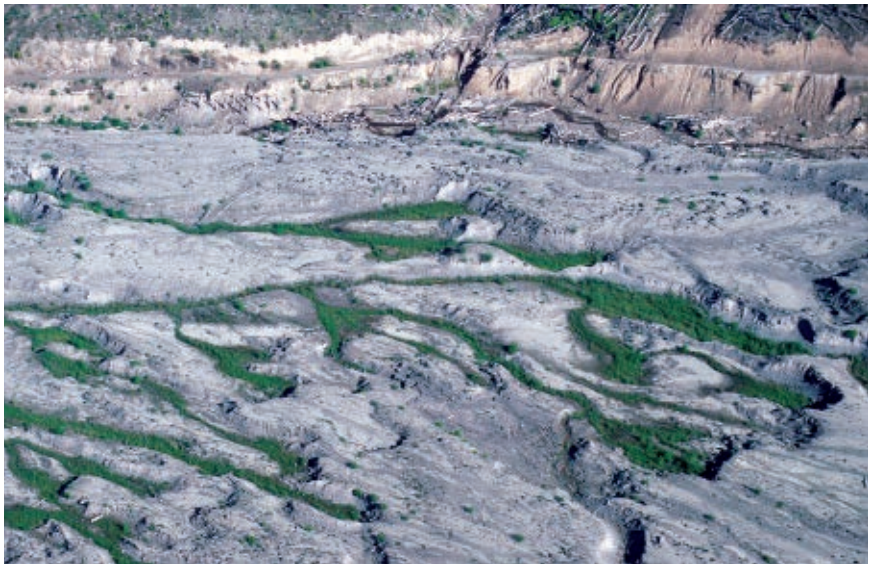
where groundwater is available and have literally overshadowed slow-growing conifers such as Douglas fir and western hemlock, Frenzen says. Only when the fast-growing trees mature, die and fall over — a process that will take decades — can the suppressed conifers rise to prominence, he adds.

Many factors have influenced the rate at which plants repopulated the landslide deposits. For example, plants with seeds carried by wind or by highly mobile creatures like birds moved into the blast zone faster. And because most plant species recolonized the blast zone from its edges, slender swaths of devastation such as the deposits in the relatively narrow North Fork Toutle River valley were colonized sooner than broad areas like the pumice plain near the base of the volcano.

Animal recovery on landslide deposits has been slow as well. Field surveys before the 1980 eruption noted 15 amphibian species in the area, says Frenzen. The eruption wiped them all out; scientists surveying one wetland site on the avalanche debris didn't spot any amphibians at all until three years after the eruption, when researchers found two species: *Bufo boreas*, the western toad, and *Pseudacris regilla*, the Pacific tree frog. Even today, no more than a handful of the region's original amphibian species dwell on the landslide debris.



The lateral blast damaged or destroyed 150,000 houses worth of timber. Note people standing in left foreground.



Even nine years after the eruption, vegetation — largely concentrated around stream channels and seeps — covered only about 10 percent of the hummocky landslide debris in the North Fork Toutle River valley.

Creatures living in ice-capped lakes at the time of the eruption had better chances of survival, as did subterranean creatures and small animals such as pocket gophers. Many migratory creatures had yet to return to the area for breeding or spawning season that year, so they were never at risk.

And because the event occurred midmorning, fortune smiled on nocturnal creatures, many of which had returned to their daytime hideouts before the mountain roared.

Today, some parts of the blast-scarred region teem with the highly mobile creatures that quickly recolonized the transformed ecosystem. Killdeer and red-winged blackbirds thrive along the densely thicketed edges of lakes and small ponds where beaver busily harvest trees to build lodges and dams. Herds of elk forage the open valleys, and hawks dive-bomb for rodents alongside fish-snatching osprey.

Muddy waters

Yet ecological recovery along waterways with unstable channels has been spotty. On some hillsides, fresh wounds appear where massive slumps of unconsolidated ash have spilled from the mountain and wiped the slate clean. These denuded areas, as well as the immense amounts of ash and sediment still slathering the region's floodplains, boost the amount of silt in rivers and streams.

That's especially true along the floodplain of the North Fork Toutle River, says Jon Major, a hydrologist with the U.S. Geological Survey in Vancouver, Wash. Because erosion is constantly sculpting the loose material left by the landslide and subsequent lahars, plants — especially perennials that require stable soil — have had a tough time gaining a foothold.

That dearth of vegetation has helped keep the sediment load in the river high. Just after the eruption, each liter of river water held several hundred times the amount of sediment it carried before the event. Even today sediment load is 50 to 100 times pre-eruption levels. Other rivers that drain the peak still carry about 10 times the sediment they did before the eruption, Major says.

Although the loose material already on the floodplains may be the major contributor to this increased sediment load, another source may be the steep flanks of the volcano itself. "Ever since the May 18 eruption of 1980, that

L. TOPINKA/USGS

mountain has been pumping out debris flow after debris flow," says Portland State University's Burns.

The material in those slumps comes from two main sources, he notes. One is the immense volume of fractured rock that fell back to Earth after being hurled skyward in volcanic plumes during the May 18 and subsequent eruptions. The other is the halo of glacier-scraped bits left behind as the peak's ice masses — which somewhat stabilized the material — retreated upslope, both in the wake of the eruption and as climate has warmed in recent years. "When you climb the mountain, the last hour or hour and a half is two steps up, one step down, two steps up, one step down," Burns says. "This stuff is two or three feet thick, and that's the type of material that's being mobilized."

Prodigious sources of loose glacial sediment can be found on all Cascade volcanoes, Burns reported in Portland last October at the annual meeting of the Geological Society of America. "You have the material, you have the steep slopes, you have no vegetation to hold the material in place, and all you have to do is add water," he says.

The landslide risk from that material will only increase if the climate gets warmer in coming decades, he speculates. Retreating glaciers have already exposed immense quantities of loose sediment that had accumulated on the volcano's flanks before the eruption, and a shorter snow season means that the material will be exposed to erosion-causing rains for more time each year.

Beginning this summer, Burns and a few of his graduate students will be surveying Mount St. Helens, mapping the volumes and locations of its loose material and then creating a map depicting the risks of landslides. "It's going to be a lot more extensive than we'd thought before," he notes.

Researchers will document the recovery of the terrain around Mount St. Helens for generations to come as ecological succession gradually restores the dense old-growth forests that covered the area before the eruption. And though the chances of another major eruption during that time are slim, someday Mount St. Helens will explode again, smothering the landscape in a mantle of ash and beginning the process anew. ■

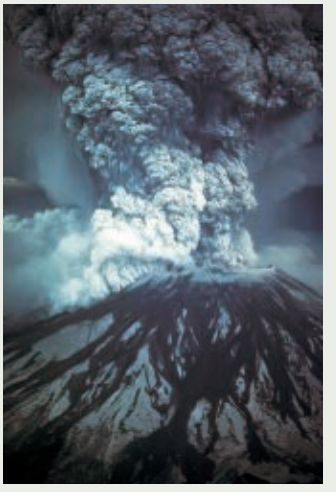
A. POST/USGS

Predicting if what goes up will fall back down

Even after 30 years, scientists are gleaning fresh insights from images taken during Mount St. Helens' latest major eruption. New studies of photos and video shot that day may help volcanologists predict whether an ash plume rising into the stratosphere might be on the verge of collapsing back to Earth in a rain of debris.

From 11 a.m. to about 12:15 p.m. on the day of the 1980 eruption, Mount St. Helens spewed up to 13,000 metric tons of hot gases and rock each second. During that interval the plume over the peak could pull in enough air to be fully buoyant, like smoke going up a chimney. Images taken that morning show that the swirling eddies around the edges of the plume measured about 560 meters across.

But much of the plume collapsed from 12:15 p.m. to around 4:25 p.m., as the volcano's vent widened and mass flow through the crater more than tripled. Instead of rocketing skyward, pyroclastic flows of hot gas and rock rolled down the mountain's flanks. During this phase the ash plume's eddies measured, on average, only 370 meters across. Researchers speculate that the plume collapsed because these smaller, more tightly spaced swirls couldn't pull in enough air to keep the rising pillar fully buoyant.



Mount St. Helens' 1980 eruption was the largest ever seen in the lower 48 states.

"The real trick for an ash plume is to incorporate enough air to become buoyant before it loses its upward momentum and collapses," says James E. Gardner, a geologist at the University of Texas at Austin.

Now, for the first time, recent analyses of images captured that day provide vital clues about what happens inside a volcano's thick ash plume, he and colleague Benjamin J. Andrews report in the October 2009 *Geology*.

Although the May 18 eruption is one of the best documented eruptions in history, scientists don't have images showing the ash plume's transition, says Gardner. So, he notes, it's not possible to discern how quickly that transition took place or whether the plume displayed advance warning of its impending collapse.

It's tantalizing to think that scientists could spot early indications that a plume was on the verge of falling back to Earth, says Gardner. And even though data from Mount St. Helens can't answer that question, he notes, his team's findings nearly 30 years after the explosion open up new avenues for studies of future eruptions. —*Sid Perkins*

Explore more

- Visit the Mount St. Helens National Volcanic Monument website at www.fs.fed.us/gpnf/mshnvm/
- R. Carson. *Mount Saint Helens: The Eruption and Recovery of a Volcano*. Sasquatch Books, 2002.

Can you hear me now?

Astronomers reconsider how extraterrestrials could make contact

By Elizabeth Quill

The Earth is going silent. Digital television signals delivered by cable and satellite are quickly replacing analog broadcasts and reducing the number and power of radio waves leaking into space. For viewers at home, it means more channels and pictures of unsurpassed clarity. But for scientists seeking signs of advanced civilizations beyond the solar system, this sudden radio silence makes the search fuzzier.

Since traditional searches for extraterrestrial intelligence, collectively dubbed SETI, have assumed that the path to intelligence proceeds similarly throughout the galaxy, SETI researchers are now wondering: If extraterrestrials can't hear us, how will we hear them? Some serious rethinking may need to be done. Much of the hunt for signals from ET so far has been based on a fading fad — a century-long blip of radio mania — rather than an enduring characteristic of galactic societies.

It's not just television. Military radar, once the prime outgoing evidence for intelligence on Earth, now jumps from channel to channel, to confuse enemies trying to jam the signal. And the power radiated by cell phones is spread across more than a thousand channels, making the waves — to a planetary outsider — indistinguishable from noise.

"Our improving technology is causing the Earth to become less visible," says astronomer Frank Drake, SETI's paterfamilias. "If we are the model for the universe, that is bad news."

For SETI researchers, that bad news comes after 50 years of no news. Since Drake first turned a radio telescope to the nearby stars Tau Ceti and Epsilon Eridani in 1960, there have been no signs of ET phoning Earth or phoning home — or phoning any other intelligence in the galaxy, for that matter.

"We have all seen our little bumps in the night, but we have never had repeated signals," says Paul Horowitz of Harvard University.

In the past, failed SETI searches have fueled further efforts. And now, even in the face of the latest discouraging realiza-

tion about the potential obsolescence of radio waves, optimism persists. Instead of packing up their radio telescopes, SETI researchers are reassessing what they look for and how they search. While signals from space are scarce, ideas for alternative strategies have been proliferating like new HD programming on TV.

SETI efforts are expanding the search to a wider range of electromagnetic channels, both at radio and optical frequencies. Some researchers propose new detection possibilities based on forecasts of what technologies extraterrestrials hundreds or even a million years ahead of Earthlings might possess. Other alien hunters argue for casting an even wider net, challenging scientists to open their minds to any unexplained signals as possible subtle footprints of life from beyond.

After all, now would be an unfortunate time for SETI to die. Evidence for potential life outside the solar system is piling up in the form of planets orbiting other stars. At the time of Drake's first search, no one knew whether such planets existed. Astronomers have since found more than 400 exoplanets, and NASA's Kepler mission is scanning the skies to find any that resemble Earth.

"All of astronomy has come to embrace this idea that there must be life out there," says Gerald Harp of the SETI Institute, a nonprofit organization in Mountain View, Calif., that has been the powerhouse behind much of SETI.

The challenge: "Out there" is a pretty big place.

SETH SHOSTAK

The Allen Telescope Array, in California, will scan the sky across an unprecedented range of frequencies in searching for signals from extraterrestrials.

Drake Equation

Soon after his first search for extraterrestrials, Frank Drake proposed an equation to estimate the number of civilizations sending detectable signals.

$$N = R^* \times f_p \times n_e \times f_\ell \times f_i \times f_c \times L$$

- **N** The number of civilizations in the Milky Way galaxy with which communication might be possible
- **R^*** The average rate of star formation per year in the galaxy
- **f_p** The fraction of stars in the galaxy that have planets
- **n_e** The average number of planets that can potentially support life per star with planets
- **f_ℓ** The fraction of those planets that actually go on to develop life at some point
- **f_i** The fraction of those planets that develop intelligent life
- **f_c** The fraction of intelligent civilizations that develop a technology that releases detectable signs of their existence into space
- **L** The length of time such civilizations release these detectable signals

The ET lottery

There are roughly 300 billion stars in the Milky Way. Any life around any one of those stars could be broadcasting radio waves at frequencies ranging from 30 kilohertz to 300 gigahertz.

Covering that kind of ground — or in this case space — requires a lot of listening.

In 1960, Drake's Project Ozma (named for the queen in L. Frank Baum's Land of Oz) used a telescope in Green Bank, W. Va., to monitor two stars at 1.42 gigahertz, the radio frequency emitted by the neutral hydrogen atom. Drake tuned to this channel because, he thought, ET would be aware of water's significance for life. Turns out it's practical, too: The frequency falls within a quiet range that has little interference from human or natural sources. Since 1960, searches that target individual stars and those that sweep the entire sky have been conducted in a systematic way at frequencies between 1 and 3 gigahertz, but not much lower or higher.

That's like trying to find a movie on HBO by randomly flipping to just one out of more than a hundred channels — assuming that your cable package includes HBO, the volume is loud enough and you've picked the right time for the movie you want to see.

"It's a real long-shot bet," Drake says.

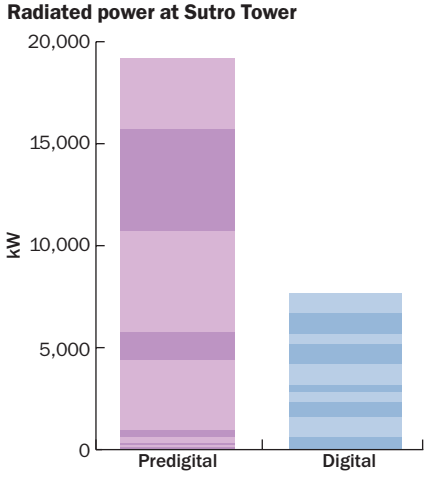
One sure way to improve your chances is to try more channels. A new project using that strategy, the Allen Telescope Array, is under construction northeast of San Francisco. Of its 350 proposed telescopes, 42 are operational. The array will simultaneously monitor more than a billion channels from 0.5 to 11 gigahertz.

At an American Astronomical Society meeting in January, Harp described the array's ability to search at a frequency of 4.462336275 gigahertz, in what's called the PiHI range, because it's the hydrogen atom's emission frequency times pi, another value ET might know. Other similar systems — the Low Frequency Array headquartered in the Netherlands, the Atacama Large Millimeter/submillimeter Array under construction in Chile and the Square Kilometer Array (location to be determined) — will follow the Allen array's lead. All of these systems, basically big telescopes built from small ones, will also cover more sky than their single-dish counterparts.

Beyond the radio realm

Radio telescopes, though, aren't the only eyes on the skies. Some searches have been looking out into the darkness for pulses of light, which have frequencies higher than those of radio waves.

When Giuseppe Cocconi and Philip Morrison suggested the possibility of interstellar communication via electromagnetic waves in a 1959 paper in *Nature*,



Digital switch When Sutro Tower in San Francisco converted to digital broadcasts in 2009, its radiated power dropped by more than half—a sobering sign for SETI researchers.

no human-produced light could have been detected at interstellar distances.

"In the '50s, if you wanted a bright search light, you'd go to GE," Horowitz says; the brightest light came from bulbs. "We couldn't have predicted the laser."

Today, powerful lasers can create light pulses that would outshine their nearest stars for a billionth of a second. Astronomers observing a momentary burst of extra light from a distant star could infer that it came from ET, since most light from natural sources lasts much longer.

Though such searches are ongoing, Horowitz says optical SETI programs should really look at infrared frequencies, just lower than those of visible light.

"Stars are darker in the infrared and lasers are brighter and the smog goes away," Horowitz says. Infrared allows astronomers to see into the galactic center, where dust scatters visible light.

For the most part, infrared channels have been off-limits, but technologies from other fields may soon make these searches possible. The communications industry, for example, has developed detectors sensitive enough to spot just a few photons of high-frequency infrared light. And solid-state photodetectors are sensitive at all infrared wavelengths.

Other scientists, and SETI enthusiasts, have proposed hunting in different electromagnetic realms—like gamma rays. Spacecraft that rely on nuclear fusion or antimatter-matter annihilation as a power source might produce such rays. But standard SETI strategy does not embrace such "speculative" scenarios.

"We are very conservative at SETI," Drake says. "We assume in our searches the existence of only things we ourselves have and know how to make."

Detectable and recognizable

There are people, however, who try to imagine what life could be like thousands of years from now. They're called science fiction writers, and in their worlds a roving researcher can travel the galaxy, interstellar civilizations can chitchat via music and light shows and, yes, antimatter-matter annihilation can fuel the *Enterprise*.

SETI researchers, some say, should also contemplate what technologies supersmart aliens might possess and seek out the corresponding signals. In a paper posted at arXiv.org in 2008, John Learned of the University of Hawaii at Manoa suggested that ET could be sending beams of neutrinos Earth's way. These elementary particles travel close to the speed of light and pass through ordinary matter undisturbed. Energy requirements for such a beam make that scenario seem implausible, but not necessarily impossible.

Detectors currently under construction—such as IceCube at the South Pole—could spot unexpected stray neutrinos. If a few with the same energy came from the same direction, astronomers would know something screwy was up.

In another paper, Learned suggests that ET could send a signal using a neutrino beam to deliver energy to a Cepheid variable, a type of star that has a pulsation period that depends on its luminosity.

A Cepheid "blows up and comes crashing back down," he says. "And the energy builds up and it blows again, like a geyser." ET could leverage a Cepheid's inherent instability by delivering a boost of energy that messes with the star's schedule.

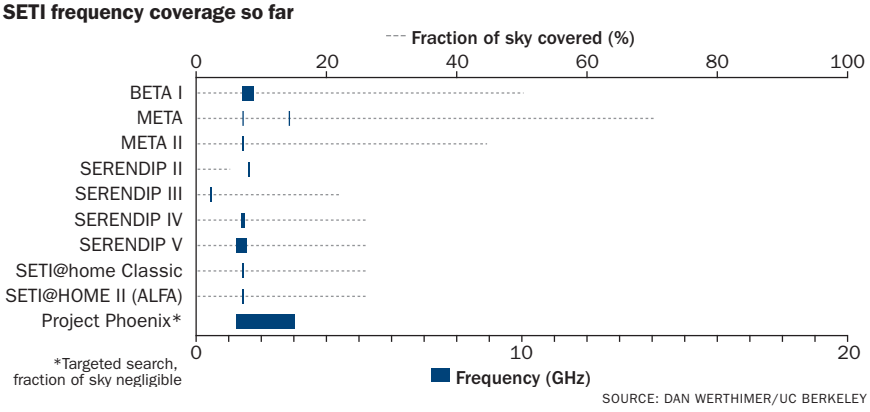
Looking through existing data could reveal whether such meddling has occurred. "All that is needed is people analyzing for other reasons to do their analyses in another way," Learned says.

Although Learned's argument may have its holes, radio wave purists beware: History has shown that the line between science and science fiction is often blurry.

In his 1937 novel *Star Maker*, Olaf Stapledon describes a future galaxy in which every star is "surrounded by a gauze of light traps, which focused the escaping solar energy for intelligent use." In 1960, physicist Freeman Dyson suggested actually searching for a similar shell of matter around a star (these artificial biospheres are now called "Dyson spheres"). Advanced civilizations, he argued, might construct such a system of orbiting satellites to capture a star's energy.

"This is a good thing to look for," Drake

Unheard channels Major radio searches for extraterrestrial intelligence conducted in the past 50 years have covered just a small portion of possible radio frequencies, mostly focusing on the range between 1 and 3 gigahertz. Ongoing and future searches conducted with the Allen Telescope Array will cover more channels by simultaneously searching the 0.5 to 11 gigahertz range. Researchers also hope to scan more sky, and improve sensitivity, to search deeper into space.



SOURCE: DAN WERTHIMER/UC BERKELEY

BOTTOM: T. DUBÉ

says, as it is detectable and recognizable.

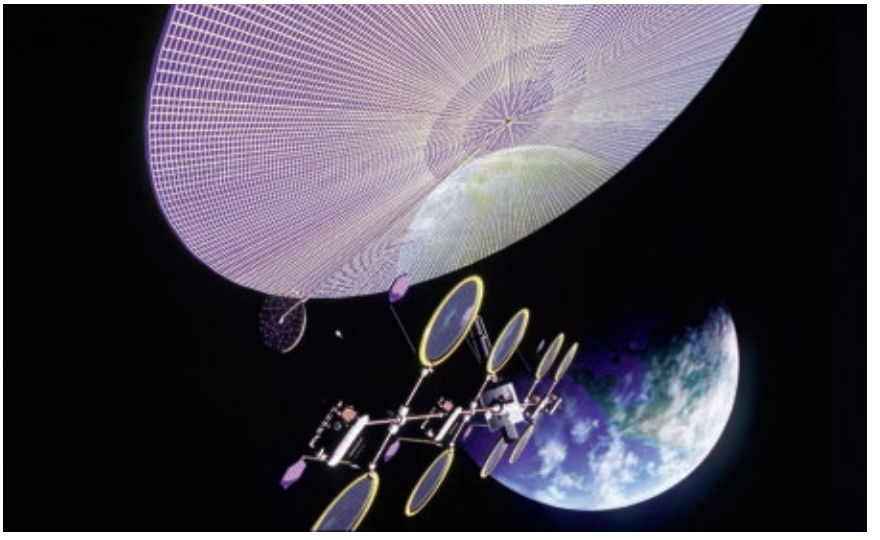
A few searches have, in fact, looked at existing data for waste heat radiated by such spheres, but have found nothing.

In the meantime, Drake proposes that scientists look for another type of satellite — similar in that it captures energy from the sun. Space-based solar power stations may someday soon become a reality around Earth. Drake speculates that an Earth-orbiting station radiating a gigawatt of power back to Earth would leak about 1 percent — 10 million watts — into space, a powerful narrowband signal.

"We don't have to do anything special to look for these," Drake says.

He and most others agree that SETI's approach should be multidirectional — let a thousand alien hunters bloom. The only ideas that don't do anybody any good, Horowitz says, are the ones for which there is no conceivable way to look. "I'd like to keep an open mind," he says, "but not so much that my brain falls out."

Physicist Paul Davies of Arizona State University in Tempe, however, suggests that researchers don't need to know what to look for. Find the fishy thing first, and then argue about its origin, he says.



NASA

If ET built a space-based power station (artist's conception) to capture energy from a star, the power leaked into space could be detected by radio telescopes on Earth.

Out of the box

Davies hosted a conference at Arizona State in 2008 to get scientists thinking about possible signatures of alien technology. He contends that SETI programs shouldn't just look for what's fashionable (because it won't be fashionable for long). Instead, look for any strange signature.

"What has happened, in a way, with SETI is that it has become almost respectable," Davies says. "It started as a daring fringe activity."

Davies doesn't think the idea that extraterrestrial intelligence would contact Earthlings directly via a narrowband radio beam is credible. Extraterrestrials wouldn't know about Earth intelligence unless they lived within a few dozen light-years, the distance Earth broadcasts have traveled. And he doesn't think eavesdropping on extraterrestrial-extraterrestrial communication is realistic, either. Long-distance conversations would probably be spread across many channels and difficult to separate from background noise.

Instead, Davies argues that SETI programs need to look for "footprints" in the cosmos or here on Earth, and he calls on all scientists to get involved by simply being aware (see Page 30). Geologists might take note of any odd formations or signatures — similar to the natural nuclear fission reactor that went critical 1.5 billion years ago in Gabon. When cosmic anomalies emerge — like the absence of expected planets, lighter-than-predicted comets or odd spectra from stars — astronomers could consider ET interference. And biologists could look for encoded messages through repeated patterns in viral RNA.

Perhaps aliens are millions of years ahead of humans: The Earth is relatively young. If ET passed through Earth's neighborhood before humans evolved, maybe the travelers left a yet-to-be-detected monument or yet-to-be awakened machine on the moon or at the Lagrange points — the five orbital positions where objects can be stationary relative to the Earth and the sun.

"SETI requires a little bit of suspension of disbelief," Davies said in a talk in January at the Royal Society in London. "If we are going to make progress, we need to think a little bit outside the box."

Like Davies, many at the SETI Institute advocate recruiting the help of people outside the community. A program called setiQuest was launched in 2010 after Jill Tarter, director of the institute's Center for SETI Research, received a prize from the nonprofit group TED for her wish to "empower Earthlings everywhere to become active participants in the ultimate search for cosmic company." The program encourages the public to develop new ways to analyze radio signals.

"The idea is that we scientists have a narrow scope," Harp says. Such efforts will get the data out to the world. "Maybe we will discover new classes of signals that we have just been ignoring because we haven't thought of them."

As Davies has argued, maybe discovering ET does indeed depend on a thought revolution. Fifty years of signal-less searching suggests that the problem could lie not with the aliens among the stars, but with ourselves.

If human technology currently scanning the stars is not up to snuff for detecting ET's messages, then SETI is a waiting game. But if human imagination is the limiting factor, then a mental shake-up may be just what's needed to spot an interstellar dispatch amid the seeming silence of space. ■

Explore more

- SETI Institute: www.seti.org

Gambling on experience

Perceptions of risk can get pulled in opposite directions

By Bruce Bower

Data, like children, can be raised wrong. Then they become an embarrassment.

Consider the retraction on February 2 of a study suggesting that the measles-mumps-rubella vaccine had caused a small number of children to develop autism. The now-debunked study, published in 1998 in a major medical journal, fueled parents' fears about vaccinating children. So it stands to reason that reluctant parents, upon reading about the retraction, will drag their kids to the doctor for a shot and a lollipop.

Don't bet on it.

A growing body of research indicates that people making decisions interpret the chances of encountering rare events, such as a child developing tragic complications from a vaccine, in dramatically different ways.

"There's an explosion of interest in studying how people acquire the information on which they base risky decisions," says psychologist Craig Fox of the University of California, Los Angeles, who helped generate an influential model that predicts how people will make gambling decisions depending on descriptions of the odds.

People who learn about the likelihood of encountering a low-probability, high-impact event via descriptions that include precise probabilities tend to overestimate, by a lot, the chances of that event actually occurring. Vaccine-o-phobic parents have typically never seen a child sink into autism after an MMR injection and never will (*SN Online: 2/3/10*). But they have heard scary secondhand accounts, read celebrity-penned tales of vaccine horrors and scanned government statistics on the minuscule but still real chances of side effects unrelated to autism. These parents sit on what might be called the "descriptive cusp" of risky decision making. External information prompts them to overestimate kids' likelihood of suffering actual MMR side effects. Autism looms menacingly in this context.

But there's another side to risk. Since 2003, investigators have documented a strong tendency for people to underestimate the actual likelihood of rare events when using experience as a guide. Unlike parents, physicians weigh vaccine side effect statistics and tales of terrors against a rich vein of personal experience — the many patients the physicians have vaccinated with no ill effects. As a result, M.D.s tend to underestimate the possibility of patients developing real but infrequent

SARAH JANE COLEMAN

vaccination side effects and are befuddled by parents' unfounded autism concerns.

Decision making based on experiences such as this one is beginning to draw intense scientific interest. New work probes how personal experiences twist risk perceptions differently from assessments that include probabilities. Evidence from gambling games suggests that decisions based on personal experience may actually benefit from peoples' limited memories. A third line of investigation explores how disaster exposures in different countries shape people's sensitivity to human fatalities and their willingness to endorse risky public health programs. And scientists are examining the nature of decisions that blend experience with secondhand descriptions, with an eye toward improving the effectiveness of federal medication warnings and product recalls.

Paradoxical terror

For more than 30 years, psychologists have used gambling games to chart people's tendency to overestimate the chances of hitting the jackpot, or losing big, when given exact probability figures.

But Israeli college students' seemingly incompatible reactions to a string of suicide bombings highlight the limits of that approach, says psychologist Greg Barron of Harvard University. The bombings occurred on 71 days between September 30, 2000, and August 31, 2002.

When tested in the weeks after bombings had been publicly called off by Palestinian leaders, a group of 43 students reported taking special precautions on days after attacks with fatalities. Students' cautious behavior reflected an experience-based overestimation of the probability that bombers would immediately strike again, as happened on 17 percent of days following deadly attacks. In a life-or-death situation, such overestimates make sense from a safety standpoint.

Despite the behavior exhibited by the first group, another group of similar students reported believing that the chances of another suicide attack were less the day after a fatal attack than after a quiet day. In fact, bombers struck on only 9 percent of days following a quiet day, suggesting students underplayed the chances of history immediately repeating itself when asked to provide an absolute risk estimate.

"Overweighting and underestimation of rare events apparently coexist in the same individuals," Barron says. These paradoxical results, published in the October 2009 *Judgment and Decision Making*, contradict a long-standing scientific assumption that probability estimates — although often incorrect — guide real-life gambles.

Barron's study, conducted with Eldad Yechiam of Technion–Israel Institute of Technology in Haifa, also challenges a popular view that people underestimate the risk of a rare event mainly because they can remember only a few recent, remotely relevant personal experiences. In fact, Israeli students had plenty of vivid memories of recent suicide bombings.

Contrasting intuitions about the causes of sequences of events may have shaped the students' assessments of risks, Barron suggests. A focus on attacks as the intentional acts of human agents may have created an anticipation that bombers would immediately strike again, explaining cautious behavior, he proposes. That's akin to what's called the hot-hand fallacy, in which observers believe that, say, a basketball player who makes several shots in a row will make the next shot because he's "in the zone."

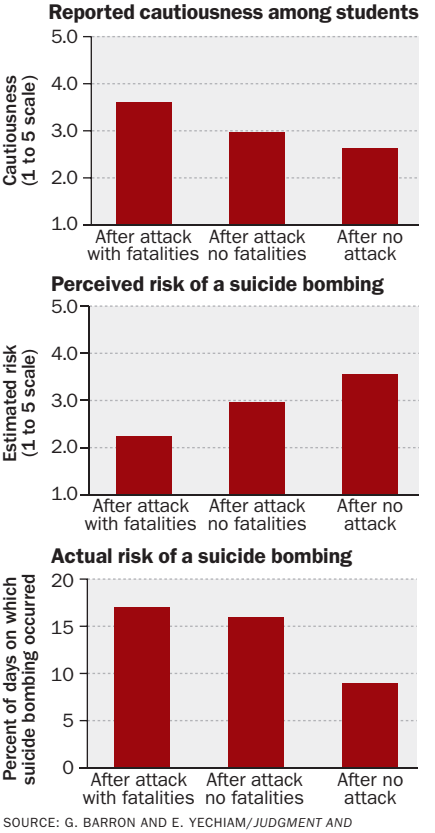
In contrast, an impersonal focus on the probability of another bombing the day after a fatal attack could have prompted students to appeal to their understanding of random chance. Previous studies suggest that people regard chance as a process ensuring that whichever of two possibilities last happened will likely change the next time around, Barron says. That corresponds to the gambler's fallacy, in which, say, a roulette player believes the ball is bound to land on black after settling on red several times in a row.

Much remains unknown about conditions that encourage the hot-hand or the gambler's fallacy, remarks psychologist Ralph Hertwig of the University of Basel in Switzerland. "I know of no data on how many people who go to casinos accept the gambler's fallacy or the extent to which either of these effects differ across individuals," he says.

Sampling power

Hertwig suspects that people flexibly adopt different decision-making strategies to deal with life's shifting, ambiguous risks. In support of that possibility, sev-

Coexisting concepts In fall 2000, a period of Palestinian suicide bombing in Israel began (car explosion in 2001 shown). A study found that the behavior of Israeli students reflects an overestimation of the risk of a bombing on a day following a fatal attack, while students' probability estimates underplay the risk of a bombing immediately after a fatal attack.



SOURCE: G. BARRON AND E. YECHIAM/*JUDGMENT AND DECISION MAKING*

LEFTERIS PITARAKIS/AP PHOTO

eral models of experience-based choices do comparably well at predicting safe and risky choices in gambling games, says Technion psychologist Ido Erev. His team posted extensive data online from experience-based gambling games that he conducted, and other researchers competed to see whose model best explained the results. In the games, volunteers sat in front of a computer that displayed two unmarked buttons. Participants could press the buttons repeatedly, one at a time, to discover the likelihood of winning and losing bets. Clicking one button might deliver nothing most of the time with an occasional $10 payoff, whereas clicking the other button might always pay out $1. Participants decide how many times to press buttons before making a choice between the two bets.

Each set of competing researchers then tested how well their approaches explained Erev's findings. Competition results covering 14 different decision-making models appear in the January *Journal of Behavioral Decision Making*.

Six models that predicted a large majority of participants' experience-based choices share the assumption that a decision maker consults only a handful of recent outcomes before taking the plunge. One particularly successful model implemented a procedure for taking into account past gambles that had probabilities similar to whatever options were currently under consideration.

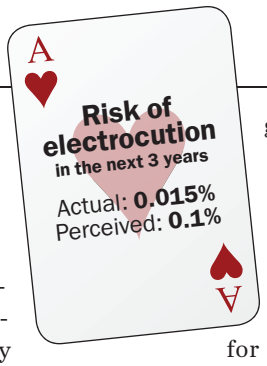
Another winning model, codeveloped by Hertwig, assumes that decision makers estimate the average return for each of two options over the past seven times that each was chosen. That's because participants in experience-based gambling games run by Hertwig usually observed no more than seven outcomes for each of two options before selecting one of them.

This frugal approach helps to speed decision making and amplifies the difference between two options' average rewards, Hertwig says.

Consider a gamble offering a 10 percent chance of $32 and a 90 percent chance of nothing, as well as an option that always pays $3. Over the long run, taking the risky gamble every time would yield $3.20 for every $3 reaped by always opting for the sure thing. But in Hertwig's studies, most volunteers observed between five and nine outcomes for the risky bet, a tactic that often resulted in no big wins. As a result, participants sampled average payoffs of zero for the risky bet and $3 for the safe choice.

Nearly all of these participants chose the lower-paying, safe bet. The volunteers who did happen to see one or more big wins chose the risky bet. But consider a case in which the sure thing pays more than a risky bet over the long haul. In that situation, the amplification effect would lead volunteers to choose the higher-yielding gamble.

In fact, in a reanalysis of data from volunteers who sampled between one and 100 results for various experimental



gambles, Hertwig and Timothy Pleskac of Michigan State University in East Lansing found that those who first observed as few as seven results for each choice selected the one with a higher average payoff 86 percent of the time. That figure rose to 95 percent for those who sampled 100 results for each option — a modest improvement for so much more time and effort.

When faced with a real-world quandary about how to pick between, say, two stocks or two cars, there's no simple way to know when to stop gathering information (see Comment, Page 32). "The amplification effect in small samples not only makes it easier to choose between risky options, but the likelihood of picking the option with a higher value over the long run stays relatively high," Hertwig asserts.

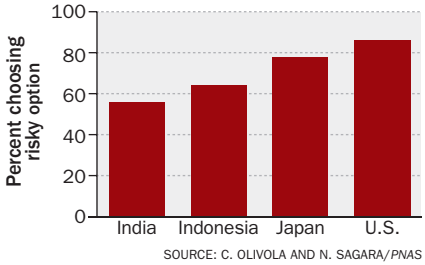
Shocking deaths

Sometimes people's experiences over the long run exert a surprisingly powerful, if unappreciated, influence on how they pick between risky options. Previous exposures to small- or large-scale death tolls can shape the extent to which individuals feel shock and concern upon learning of deaths in new tragedies, remarks psychologist Christopher Olivola of University College London. Close encounters with calamities also manipulate people's willingness to endorse risky public health measures, he adds.

Valuing death Residents of wealthy nations tend to be unfamiliar with large death tolls, while people in less developed nations, such as Indonesia (damage from a 2003 flood that killed 66 people shown), have more experience with such disasters. People living in the United States and Japan are more likely to support a public health program that risks 40 lives than are people from Indonesia, a recent study finds.

AVIE/AP PHOTO; SOURCE FOR CARDS: P.W. LINVILLE *ET AL.* IN *THE SOCIAL PSYCHOLOGY OF HIV INFECTION*, 1993

Support for a risky public health program



SOURCE: C. OLIVOLA AND N. SAGARA/*PNAS*

Deaths from major natural disasters

	2000–2009	1990–1999	1980–1989
U.S.	4,212	3,601	4,411
Japan	800	6,161	1,487
India	59,357	49,939	32,592
Indonesia	179,934	7,602	3,628

SOURCE: WWW.EMDAT.BE

It's a brutal calculus of concern, report Olivola and psychologist Namika Sagara of the University of Oregon in Eugene in the Dec. 29 *Proceedings of the National Academy of Sciences*. A global database of natural and industrial disasters shows that wealthy countries, such as Japan and the United States, tend to experience much smaller death tolls from these events than poor countries, such as Indonesia and India, the researchers say.

Unfamiliarity with large death tolls feeds into a previously reported tendency of those in wealthy countries to become increasingly insensitive to losses of life as the number of victims climbs. The difference between 10,000 and 15,000 deaths simply doesn't register, based on a lack of experience with such catastrophes, Olivola suggests.

"Our results imply that those countries in a position to provide aid or military intervention following a crisis have populations that will exhibit a strong diminishing sensitivity to human fatalities," Olivola says. "Factors other than sensitivity to the number of lives at risk will therefore motivate these countries to provide aid."

Residents of wealthy nations are also particularly keen to support public health programs with the potential either to save or kill a lot of people, he finds. In one experiment in his new study, 97 of 118 Japanese and U.S. college students — around 82 percent — endorsed a risky course of action to stem a hypothetical disease outbreak. They favored a program with a 50 percent probability of causing 40 deaths and a 50 percent probability of causing no deaths over a program that would lead to 20 deaths for sure.

In contrast, 64 of 107 Indonesian and Indian students — only about 60 percent — preferred the risky program.

It's uncomfortable to think that uncontrollable events linked to where people are living mold how they value human life, Olivola says.

MONKEY BUSINESS IMAGES/SHUTTERSTOCK

Wasted warnings

U.S. parents have no problem valuing the lives of their children. But moms and dads took a collective risk in October 2007 when an FDA committee recommended that children under 2 years of age stop taking over-the-counter cough and cold medications because of rare but potentially fatal side effects. Only one in five parents of young children contacted the next month in a national survey who had heard of the recommendation said that they would adhere to it, consistent with anemic public responses to most medication warnings and product recalls.

When given a description of a product's potential dangers, people who have safely used it for a long time fall back on their experience and resist change, says Harvard's Barron. Those on the verge of using a product or who have used it only a few times more often heed such warnings.

Still, parents with a history of safely giving their infants cough and cold medications were not immune to the FDA's advice, according to an unpublished study led by Barron and Talya Miron-Shatz of the University of Pennsylvania in Philadelphia. The researchers analyzed data from the national survey of 218 parents of children age 2 and younger, all of whom had heard of the FDA warning.

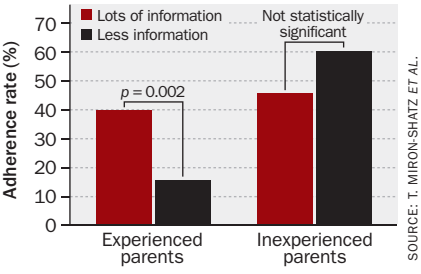
About half of 138 parents who had only one child said that they had complied with the warning, regardless of how much information they had seen about it. Among 80 parents who also had children older than 2 years, compliance plummeted to 15 percent among those who had seen brief announcements about the warning, possibly because these parents fell back on experience. But among those who had read up on potentially fatal side effects, adherence to the warning rebounded to 40 percent. Parents with older children also reported especially high levels of trust in FDA pronouncements.

"The FDA may get more bang for the buck by targeting experienced parents, who are least likely to follow its recommendations, with detailed package information rather than public announcements," Barron says.

Scientists will get more bang per study by taking Barron's cue and targeting experience's role in a host of everyday decisions, remarks psychologist Tim Rakow of the University of Essex in Colchester, England. Little is known about the hypotheses that people generate and the feelings that they grapple with when faced with tough, real-life choices, Rakow notes. All too often, individuals grope in the dark with neither experience nor probability descriptions to hang on to.

As Lyle Lovett crooned in a song about his comically inept attempts to pick up a woman in a bar, "Still the only certain thing for sure is what I do not know." ■

Parents' adherence to FDA warning



SOURCE: T. MIRON-SHATZ *ET AL.*

Acting on info Understanding how experience shapes risk perceptions could help the Food and Drug Administration target safety information and product recalls. When the FDA advised parents not to give children under age 2 over-the-counter cough and cold medicine (as shown), parents with more than one child tended to ignore the warning while new parents were more likely to follow it. When experienced parents got more information, compliance improved.

Explore more

- *Journal of Behavioral Decision Making* Special Issue: Experience-Based Decision Making. January 2010.

Here Be Dragons

Dennis McCarthy

Most people believe "Here be dragons" appears on ancient maps as a warning of the dangers rife in unexplored or unfamiliar regions. But the phrase is found on no such maps and on only one small globe, McCarthy reveals in his book, which chronicles how real creatures got to be where they are and the significance of their movements. In fact, the phrase etched over Southeast Asia on that 16th century globe may be less a warning than a note about the range of the world's largest lizard, a creature commonly known as the Komodo dragon.

In this fascinating and revelatory book, the author explains how certain species ended up in their present geographic locations and how studying this distribution has driven revolutions in earth and life sciences.

This study of where plants and animals live now and have lived in the past is formally known as biogeography, and this science above all else led Darwin to conceive the theory of evolution, McCarthy writes. Biogeography also lends strong support to the theory of plate tectonics, which explains the long-term drift, separation and collision of continents, processes that time after time have triggered climatic changes and stimulated the evolution of new species.

McCarthy persuasively argues that biogeography is more than just the place where evolution, plate tectonics, oceanography and climatology meet: It is a way of looking at the world that links all of these sciences together. Earth and life have evolved together, he contends, a process that has affected the distributions of ancient fossils, modern species and even the fates of human societies. —*Sid Perkins*

Oxford Univ. Press, 2010, 214 p., $29.95.

The Eerie Silence: Renewing Our Search for Alien Intelligence

Paul Davies

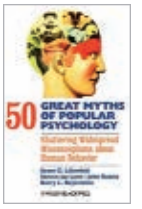
After 50 years of scanning the skies for signs of extraterrestrial intelligence, astronomers have only silence to report—an eerie silence, Davies argues.

Part history of the search, part road map for its future and (large) part mind-stretching exercise, the book provides Davies' perspective on profound questions that have implications far beyond alien hunting. Is life inevitable? What about intelligence? How long do advanced civilizations last? What would happen if alien cultures met?

Though these questions have been asked before, Davies, a cosmologist, recaps recent thinking and describes new scientific investigations. He uses the lack of clear answers to call for a shake-up in current efforts to search for life beyond Earth. Since no one can predict the nature of other intelligence, he says, scientists from all fields should look for subtle signatures of societies rather than direct communication via radio waves or some other familiar technology.

Davies makes a good case for a broader approach, but his hypothetical examples of alien footprints seem a little wild. What if, for example, the reason scientists haven't detected some of the subatomic particles predicted by theory is that the particles were abducted by aliens? And he suggests that some intelligence may be postbiological—a quantum computer, perhaps, lingering in the coldest reaches of the galaxy. Though his ideas seem fantastical, Davies' tongue-in-cheek approach is entertaining and serves a grander purpose: to encourage readers to think less about life as we know it and more about life as we don't know it. —*Elizabeth Quill*

Houghton Mifflin Harcourt Trade, 2010, 288 p., $27.



50 Great Myths of Popular Psychology

S.O. Lilienfeld, S.J. Lynn, J. Ruscio and B.L. Beyerstein

Psychologists team up to debunk popular urban legends in that field. *Wiley-Blackwell, 2010, 332 p., $26.95.*

Duel at Dawn: Heroes, Martyrs, and the Rise of Modern Mathematics

Amir Alexander

The Romantic Age zeitgeist profoundly influenced modern mathematicians, a science historian argues. *Harvard Univ. Press, 2010, 320 p., $28.95.*

Wild Urban Plants of the Northeast: A Field Guide

Peter Del Tredici

An exploration of the plant life that springs up amid chain-link fences and asphalt jungles. *Cornell Univ. Press, 2010, 374 p., $29.95.*

The Match: "Savior Siblings" and One Family's Battle to Heal Their Daughter

Beth Whitehouse

A family medical crisis uncovers issues around reproductive technology. *Beacon Press, 2010, 272 p., $24.95.*

How We Know What We Know About Our Changing Climate

Lynne Cherry and Gary Braasch

Kids can learn about climate change by reading scientists' firsthand accounts from the field. *Dawn Publications, 2010, 66 p., $11.95.*

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Naked speed

The article "Running barefoot cushions impact of forces on foot" (*SN: 02/27/10, p. 14*) says a lot about whether running barefoot is or isn't healthier than running shod. Has anyone looked into which is faster?
Henry Jones, Baton Rouge, La.

"No," responds Daniel Lieberman, a professor of evolutionary biology at Harvard University. But he does note that Abebe Bikila set a world record for the marathon at the 1960 Rome Olympics running barefoot. And Zola Budd set quite a few records running middle distances barefoot. "There is no theoretical reason why barefoot runners are necessarily slower," he says. "Further, slight differences in speed are probably irrelevant from an evolutionary perspective. Humans evolved to make animals gallop in the heat, not to win races."
— Laura Sanders

Cosmic question

Reading the article "Relic radiation refines age of cosmos" (*SN: 02/27/10, p. 7*), I was struck by a question: How could any of the radiation from the Big Bang be reaching our planet just now? How are physicists able to analyze "snapshots of the earliest light in the universe"?
Christopher Kendall, via e-mail

The ultrahot radiation produced in the Big Bang was emitted throughout the entire visible universe. So everything in the universe, including Earth, is bathed in the remnants of that radiation. Astronomers observing that radiation today see it after it has been stretched out by the expansion of the universe and cooled (putting it in the microwave range of the electromagnetic spectrum). Slight temperature differences from point to point on the sky in this cosmic microwave background radiation reflect its last interactions with matter. Most of the microwave background photons last interacted strongly with matter 13.7 billion years ago, roughly 380,000 years after the Big Bang, says cosmologist David Spergel of Princeton University, a member of the WMAP team analyzing the microwave data. So when we observe these photons today, we see the effects of interactions that occurred 13.7 billion years ago. Because of the travel time of light, we are in effect viewing the surface of a sphere 13.7 billion light-years in radius, Spergel notes. On this sphere we see conditions that are similar, but not identical, to conditions of the early universe in the location now occupied by Earth. "While we like to claim that our CMB observations are taking 'our baby picture,' we are actually taking the 'baby pictures' of stars that will form in a galaxy far, far away from us!" Spergel comments. — Ron Cowen

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

Gary Klein

For more Comment, visit COLUMNS at **www.sciencenews.org**

Jumping to conclusions can make for good decisions

Gary Klein, a psychologist and chief scientist at Applied Research Associates in Fairborn, Ohio, has for the past 25 years studied how people make real-life, critical decisions under extreme time pressure. In his 2009 book Streetlights and Shadows: Searching for the Keys to Adaptive Decision Making *(MIT Press), Klein discusses 10 surprising ways effective thinkers deal with ambiguous situations. Staff writer Bruce Bower, who writes on Page 26 of this issue about risk and decisions, recently spoke with Klein about good decision making.*

What is tacit knowledge and why do you consider it so important?

Unlike explicit knowledge of names, facts and rules, tacit knowledge is being able to do things without being able to explain how. Tacit knowledge feels mysterious when we use it. It's a fountain for our intuitions. With experience, we learn to see things that others don't notice. Knowing when to make a left turn in traffic separates experienced drivers from 16-year-olds. Only an experienced lawyer knows how to read a contract to spot potential problems for a client. Tacit knowledge includes the ability to recognize typical and unusual situations based on one's experience. Good decision makers then construct a mental story to understand what's going on. Laying out all the evidence or following standard procedures interferes with tacit knowledge.

Does it ever make sense to jump to conclusions?

It always makes sense to jump to conclusions. It's impossible *not* to jump to conclusions; we're wired for speed that way. People direct their search for information about ambiguous situations based on expectations informed by their experience. We still need to test our initial expectations against the current situation to avoid fooling ourselves. But we shouldn't follow advice to keep an open mind. How will we know when we have seen all the evidence? How long are we supposed to wait while we leave our minds on idle? Keeping an open mind makes it harder to figure out what's happening.

We have to stop treating decisions as gambles. Successful decision makers actively manage a situation and shape their options rather than passively awaiting the outcome of a gamble that has specific probabilities, risks and benefits.

It always makes sense to jump to conclusions. It's impossible *not* to jump to conclusions; we're wired for speed that way.

What is the role of making mistakes in effective decision making?

No one wants to make mistakes, but there is great value in them. My colleagues and I have found that the only time people become open to formulating better mental models of a situation is after having made a critical mistake. In one case, an expert Navy F-4 fighter pilot wanted to advance his career by learning to fly another aircraft, the A-6. But he badly botched a series of A-6 aircraft carrier landings required for certification. Only then did he consider the landing signal officer's advice to think about differences between the F-4 and the A-6. He realized that a small shift in where he sat in the A-6 cockpit caused him to misalign the plane with the carrier runway. The next day he nailed his landings.

Is it possible to predict and protect against rare and unpredictable Black Swan events that many people have no previous experience with and can't imagine before they happen?

Most people will be victimized by a Black Swan event, especially those who think that they can analyze information so carefully that they will be protected. Even when warning signs are clear, risk calculations can be terribly inaccurate and deceptive. Today's global financial crisis was triggered by miscalculations that observers had warned about for years. Even in the early stages of the crisis, many people still thought that we were OK. These types of events are hard to comprehend, so we tend to explain them away.

Organizations in particular need to prepare to react and adapt quickly to unexpected events. Think of this as risk management by discovery.

What do you tell those who have lost trust in experts and the whole notion of expertise?

One way to tell real experts from people who look like experts is to ask them about the last mistake that they made. The expert is still chewing over that last mistake and asking "What should I have been watching for?" The nonexpert will dismiss a mistake as due to bad luck or say that it wasn't a mistake at all, but due to uncontrollable circumstances.

I hate the notion of the mind as an assembly line where data get refined and processed until we can "connect the dots." That trivializes the expertise of people, from firefighters to intensive-care unit nurses, who know how to identify the dots in the first place so that they can make sense of a situation. ■

JARED JUDSON

In This Economy...

Overpaying For Luxury is Just Bad Taste

Stauer introduces the 27-jewel, automatic luxury wristwatch that's starting a retail revolution.

If there is any good to come out our rollercoaster economy, let it be the death of ostentatiousness. Motoring around in a limo and flaunting a $20,000 watch with a big "R" on the face is now considered bad manners. Ostentatiousness is what got us in trouble in the first place. Honestly, our parents taught us better than that...I know mine did. Yet so many of us still fell for the fool's gold of designer names and the notion that higher prices equal higher status. We've never had that problem at Stauer. For years we've been stirring up a sort of retail revolution. And the good news is that it has truly caught on. The Stauer ***Legacy*** Automatic is a true value. Now priced at only $95.

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