

Digital Courtroom Drama | Snakebite Salve | Neurons with Personality

ScienceNews

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MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ JULY 30, 2011

First Stars

A new look at the universe's stellar pioneers

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Irish Roots**

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Power
Themselves**

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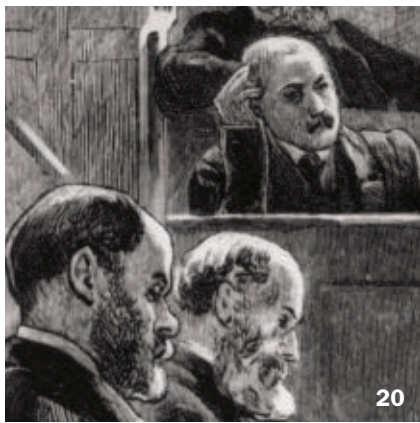
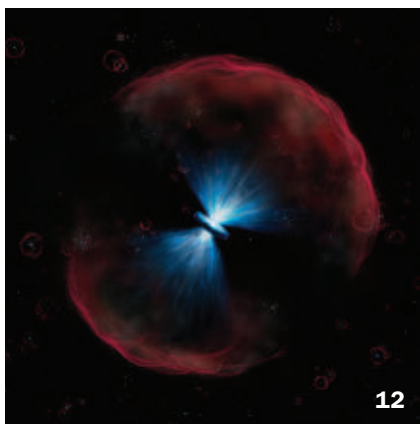
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ScienceNews



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Simulations: John Wise and Tom Abel/KIPAC

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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. Copyright © 2011 by Society for Science & the Public. Title registered as trademark U.S. and Canadian Patent Offices. Printed in U.S.A. on recycled paper.

FROM THE EDITOR

Communicating science encourages cooperation



Last month more than 700 science journalists from 90 countries congregated in Doha, the capital city of Qatar, an Arab nation on the shores of the Persian Gulf.

The occasion was the World Conference of Science Journalists, held every other year. This year's conference was jointly organized by the U.S. National

Association of Science Writers and the Arab Science Journalists Association. It was a venture in international and intercultural cooperation that ought to put the politicians of the world to shame.

Science journalists of whatever nation share several common goals, aspirations and principles, including the belief that society benefits from the communication of scientific knowledge to the citizenry of all lands. Chief among science journalists' common beliefs is an appreciation of the power of rational thought, along with confidence that differences of opinion can often be reconciled through the pursuit of relevant evidence, systematically gathered and intelligently interpreted.

Unified by the common language of mathematics and the unwavering lawfulness of natural phenomena, scientific findings transcend the cultural divides that typically permeate politics, religion, social mores and national customs. Everyone on Earth shares the same physics, the same biology, the same chemistry and the same planet. Scientific knowledge provides the common ground needed for the peoples of the world to live peacefully together. At least it could in principle.

For there to be any hope of achieving this dream, though, the knowledge produced by the scientific enterprise must be communicated to the people of the world at large, not merely exchanged among science's practitioners. That's where science journalists can play an essential role. In Doha, we shared our thoughts and experiences and discussed the challenges facing science journalists in a world that doesn't always value the messages they deliver or appreciate the implications of the science they communicate.

But it is, in fact, possible that shared appreciation of knowledge and rational methods of seeking it can foster cooperation among groups otherwise divided by distance, culture or language. The Arab and U.S. science journalists have shown that it can be done.

—Tom Siegfried, Editor in Chief

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Say What?

endozoochory \EHN-doh-ZOH-eh-

KOHR-ee \ n. Dispersal of plant spores or seeds by an animal after passing through the animal’s gut. Endozoochory is common for seed plants, but its usefulness for other taxa is largely unknown. A Swiss study published online April 13 in *PLoS ONE*

found that lichen fragments in snail feces can make a comeback, too. The researchers also found that lichen passed through the guts of larger snail species regenerated better than lichen pooped out by smaller snails. Lichen (*Lobaria pulmonaria* shown) is a symbiotic combination of fungi and algae or cyanobacteria, and while past research has shown that the separate constituents can survive gut passage, this study provides the first evidence that whole lichen can spread endozoochorously, the authors claim.

Science Past | FROM THE ISSUE OF JULY 29, 1961

RADIATION SURVIVORS — A world-wide radiation disaster might eventually give rise to two populations, research on bacteria indicates.... Starting with a culture of ordinary (wild-type) bacteria, the scientist added copper ions that produced a “disaster.” Most of the bacteria died.... But as time passed, a small number of survivors, called variants, began reproducing at a rapid rate. They were resistant to effects of poisonous copper and differed in many ways from ordinary bacteria. Eventually a second population of survivors began to appear, resembling the original bacteria in every respect except that they had just enough resistance to copper to grow slowly in the presence of that poison. Finally, the completely resistant variants disappeared.



Science Future

August 8

Hear an anthropologist speak in Houston on the evolving relationship between humans and water. Go to www.hmns.org

August 12–13

The weeklong Perseid meteor shower peaks. Watch after midnight. For more info go to <http://bit.ly/Ln3pCr>

August 20

In Ann Arbor, Mich., bring preschoolers on a morning hike to explore the outdoors. For more info, see www.lesliesnc.org

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BODY & BRAIN

Infants may learn speech sounds as they snooze. Read “Sleeping babies learn in an eyeblink.”

LIFE

Researchers find a natural screwlike joint — in a beetle’s hip. See “Weevils evolved nut-and-screw joint.”



MATTER & ENERGY

An acoustic cloak made of metamaterials reflects sound off a bump as though it were a flat wall. Read “You haven’t heard it all.”

Science Stats

WHAT’S EATING YOU?

Juvenile gators cannibalized, percent per year



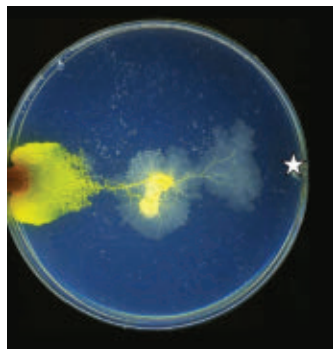
■ Eaten by other gators

Alligator cannibalism may do away with 6 to 7 percent of the juvenile alligator population each year in Orange Lake, Fla., a Florida Fish and Wildlife Conservation Commission team estimated. Nearly all eaters were adults.

SOURCE: M.F. DELANY ET AL./*HERPETOLOGICA* 2011

How Bizarre

If You Give a Slime Mold a Sedative doesn’t sound like a best-selling children’s book, but a recent study found that *Physarum polycephalum* actually prefers herbal sedatives and other dried plants to honey or oats. Andrew Adamatzky at the University of the West of England in Bristol tempted the single-celled organism with various goodies. The yellow amoeba-like blob grew toward the pills more often than it reached for honey or oat flakes (honey trial shown, star marks honey). Slime mold especially liked pills that combined hops and Valerian root, an



anxiety and insomnia treatment, Adamatzky reported online May 31 in *Nature Precedings*. The new range of attractive substances could be used to program and control the mold, which is used as a biological computer in maze solving and other calculations.

CLOCKWISE FROM TOP LEFT: PELLAE/FICKR; SCIENCE/AAAS; LOGORILLA/STOCKPHOTO; ADAPTED BY JANEL KILEY; A. ADAMATZKY/NATURE PRECEDINGS 2011

“ Why can't you think about 100 things simultaneously, or 50 things simultaneously? Why only four? ” — EARL MILLER, PAGE 10

Genes & Cells Devil's DNA in detail

Body & Brain Two slots for working memory

Atom & Cosmos Most distant quasar

Earth Floods may spawn quakes

Humans America's first art

Environment Warming hiatus explained

Matter & Energy Sensor, power thyself

In the News

STORY ONE

DNA hints at polar bears' Irish ancestry

Maternal line traced back to brown bears on Emerald Isle

By Susan Milius

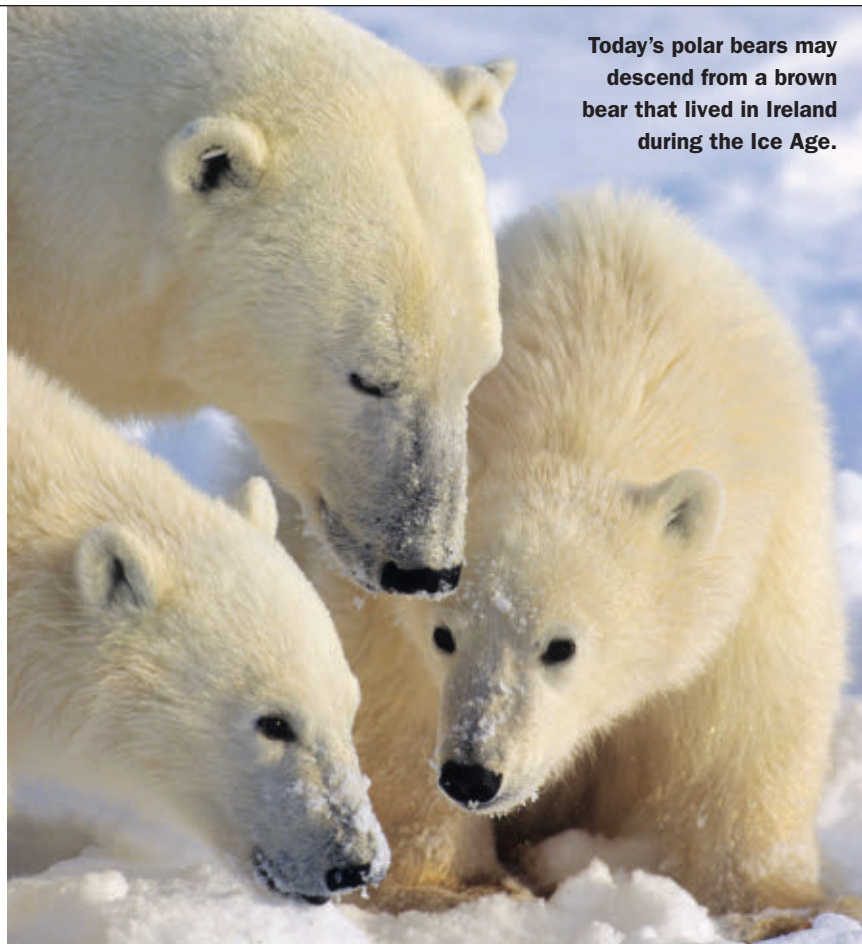
All polar o' bears living today may be able to trace their maternal ancestry back through grandmothers many times great to a female brown bear in Ireland.

Analyzing bits of maternally inherited DNA from 242 bear lineages, both modern and fossil, suggests that polar bears interbred with brown bears in or near Ireland between 20,000 and 50,000 years ago, an international team of scientists reports online July 7 in *Current Biology*. At the time, the Emerald Isle had a much colder climate.

A major Irish brown bear ancestor “was a complete shock,” says study coauthor and geneticist Ceiridwen Edwards, now at the University of Oxford in England.

While working at Trinity College in Dublin, Edwards extracted fragments of DNA from fossil brown bears found in Irish caves. Her data were among those combined to outline the last 120,000 years or so of maternal history for polar and brown bears.

Biologists have known that even today polar bears and brown bears are related closely enough that they can produce fertile hybrid offspring. Also, genetic studies had hinted at ancient



Today's polar bears may descend from a brown bear that lived in Ireland during the Ice Age.

connections of some sort between polar bears and the brown bear populations of three islands off the coast of Alaska. A lingering impact from interbreeding around Ireland was an unexpected twist in the tale.

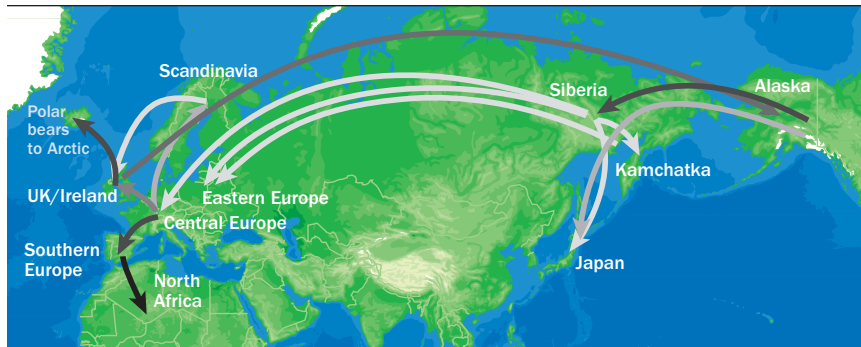
This wasn't the only important interbreeding event for polar bears, the study suggests. Evidence for other, similar events could make researchers rethink the role of hybridization in the history of these bears, says conservation geneticist Lisette Waits of the University of Idaho in Moscow.

Polar bears specialize in living on Arctic ice, a habitat shrinking so fast with climate change that the species is now listed as threatened under the Endangered Species Act. Polar bears haven't left much of a fossil record, but genetic studies and other work have suggested that the species arose from coastal brown bears.

Polar bears and brown bears can still be classified as distinct species even if they can produce fertile offspring now and then, notes coauthor and evolutionary geneticist Mark Thomas of



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Bear lineages DNA analysis can be used to reconstruct migrations of female brown and polar bears over the last 120,000 years (shown by arrows). Darker arrows indicate movements that are better supported by the data. Surprisingly, all polar bears in the Arctic today may have gotten their maternally inherited mitochondrial DNA from now-extinct brown bears living in or near Ireland and Britain 20,000 to 50,000 years ago. Other maternal lineages traveled across Eurasia and to and from adjacent continents.

University College London. The popular notion that different species can't interbreed and create fertile offspring does not reflect real-world biology, he says. Nor does the notion reflect the current debate among biologists about how to define a species.

What biologists don't generally expect is for a hybrid here and a hybrid there to create a large, lasting transfer of genetic material from one species to the other. Yet the new genetic analysis of polar bear history suggests that's what may have happened in Ireland.

The researchers traced DNA inherited only from mothers, stored in little cellular powerhouse structures called mitochondria. The team did not look at the DNA from the cell nucleus (which contains the main genetic blueprints from both mom and dad). Daughters pass along mom's mitochondrial DNA to their offspring, creating genetic bread crumbs for following back the maternal line.

When some ancient polar bear interbred with an Irish bear, the offspring inherited the brown bear mom's mitochondrial DNA. That mitochondrial DNA apparently spread through polar bear descendants as competing maternal lineages died out. "Today, all living polar bears have this brown bear mitochondrion," says coauthor and evolutionary biologist Beth Shapiro of Pennsylvania

State University in University Park.

Important as that maternal lineage is, it's only a small part of the total genetic heritage of polar bears, Thomas notes. For a person this lineage would not be mom's whole family, just the chain of descent from her mother's mother, her mother's mother's mother and so on. Forming a complete picture of polar bear origins will require nuclear DNA studies.

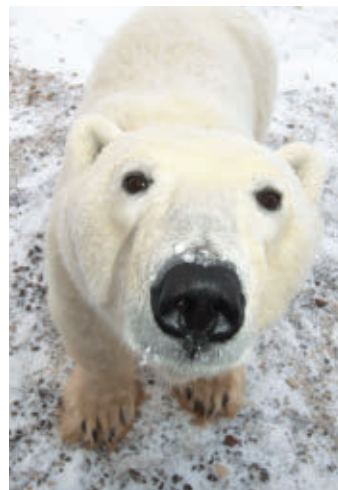
More mitochondrial DNA studies would help test the new study's propositions about polar bear history, says Charlotte Lindqvist of the University at Buffalo in New York, who has also extracted DNA from bear fossils. The

new history comes from fragments of mitochondrial DNA, not the whole mitochondrial genome. Bold claims could use more data, she says. "I'm a little concerned."

What concerns longtime polar bear researcher Steven Amstrup, though, is the possibility of downplaying the current risks facing the bears from the melting of their sea ice homes. The paper suggests that polar bears hybridize with brown bears when ranges overlap during climate upheavals. "Unfortunately, some readers may interpret this statement, offered prominently in the first section of this paper, as a suggestion that hybridization with brown bears may save polar bears from this crisis. That would be a terrible mistake," says Amstrup, now with the conservation group Polar Bears International of Bozeman, Mont.

If polar bears evolved about 150,000 years ago, as Amstrup believes, the warmest global mean temperatures they experienced were about 1 degree Celsius warmer than now. Predictions have temperatures exceeding that during the next 50 or 60 years. "Crossbreeding or not," he says, "polar bears will not be able to undo 150,000 years of evolution, or even 20,000, in 50 years." ■

Back Story | WHITE STUFF



Even with a bit of DNA that came from a brown-coated relative, polar bears still rank as a separate species with differences in body structure, range and behavior. Their most striking adaptation to life on ice—white fur.

- The bears' transparent fur doesn't have white pigment, or pigment of any color. Bears can look yellow-orange in the light of sunset or even blue in fog.
- Even though polar bear fur is transparent in visible light, it absorbs ultraviolet wavelengths. A charming proposal that the hairs act like fiber-optic cables transmitting energy from the UV light to the bear's body has been dismissed by biologists.
- Underneath that white fur is black skin. A bear that has lost hair swatches looks as if it has black spots.
- Polar bear fur can even cover the foot pads in winter. Fur engulfs just about everything except the tip of a polar bear's nose.



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Genes & Cells



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Tasmanian devil diversity detailed

First genetic blueprints don't explain cancer vulnerability

By Tina Hesman Saey

Two new complete sets of Tasmanian devil genetic blueprints hold some good news and bad news for the species. The bad news is that the marsupial's genetic diversity is among the lowest known for any species. The good news is that the devil's low diversity has a long history and may not be reason for as much concern as once thought.

This low genetic diversity “does not mean the species is doomed,” says genomicist Stephan Schuster of Pennsylvania State University in University Park. “If you maintain the entire diversity this can still be a viable species.”

A team of researchers deciphered the genetic blueprints of two Tasmanian devils named Cedric and Spirit that hail from opposite ends of Tasmania, the team reports online June 27 in the *Proceedings of the National Academy of Sciences*. The two devils differ in their response to the infectious cancer that has decimated wild devil populations.

Cedric was one of the few devils whose immune system could fight off the

infectious cancer, which started in a single long-dead devil and has since swept over more than half the island. Cedric survived two attempts to infect him with the facial tumor as part of efforts to better understand the disease, but finally succumbed to a third strain. Spirit was already infected with five tumors and was near death when she was captured. Researchers hope that comparing the two animals' genomes, consisting of all the DNA contained in the cell nucleus, will show why Cedric was partially immune to the fatal cancer while Spirit and so many others are not.

The initial analysis of the two genomes doesn't provide a clear answer, but scientists suspect that most devils have variants in certain genes that make them susceptible to the tumors.

“The really exciting discoveries are yet to come,” says Katherine Belov, a geneticist at the University of Sydney who was not involved in the study. “We are very excited to be able to jump in and start mining this genome.”

The study reveals more details about the genetic diversity of current Tasmanian devil populations. While researchers have long known that the devils have

low levels of genetic diversity, the new work shows that overall devil diversity is about 20 percent of that in humans.

The team's analysis of DNA from museum specimens dating back to 1874 — at least 100 years before the infectious cancer arose — finds that devils have long had that low level of diversity. The tumor has not reduced the amount of diversity in wild populations, researchers discovered after testing 168 wild devils.

That finding strikes a hopeful note, says evolutionary biologist Anne Yoder, who directs the Lemur Center at Duke University. “The species seemed to be doing pretty well even with that low diversity,” she says.

Low diversity might affect how well devils fight off the infectious cancer, though. Because the devils are so genetically similar to one another, their immune systems may have trouble recognizing tumor cells passed on by another devil as foreign.

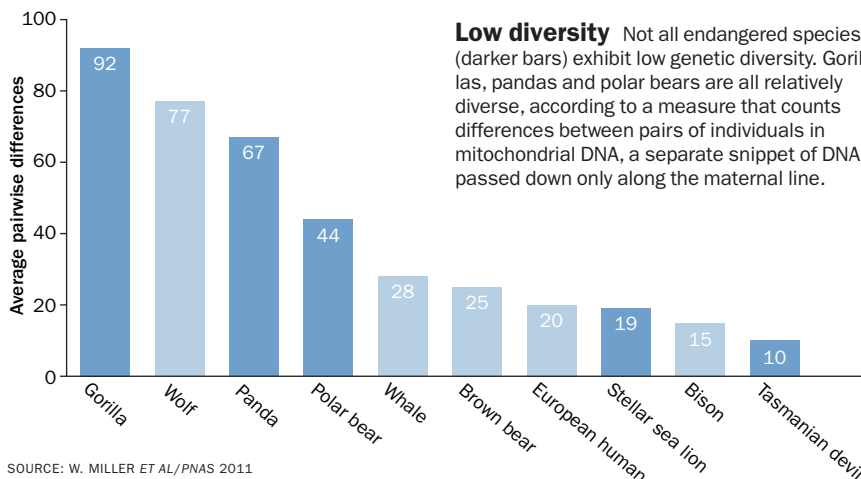
Some scientists have proposed that instead of being passed directly from one animal to another, the cancer might be transmitted by viruses during bites. But a closer look at one of Spirit's tumors showed that the cancer cells definitely came from another devil.

Schuster says that even though low genetic diversity has probably made devils vulnerable to the cancer, it's not insurmountable. Breeders should use genetic tests to match up relatively diverse mating pairs of devils instead of hoping that randomly choosing animals will maintain the fragile diversity, Schuster says. He thinks that employing the right strategies can save the Tasmanian devil.

“This is probably one of the only cases where human intervention, doing all the right things, can prevent a species from going extinct,” Schuster says. ■



Cedric, a Tasmanian devil partially immune to an infectious cancer, was one of the two devils whose genomes have been deciphered.



SOURCE: W. MILLER ET AL/PNAS 2011

\$183
billion

Estimated U.S.
health care costs for
Alzheimer's, 2011

\$1.1
trillion

Projected U.S.
health care costs for
Alzheimer's, 2050

Alzheimer's gene effect revealed

Disease-linked variant controls clearance of plaque protein

By Tina Hesman Saey

The high-risk version of a gene associated with Alzheimer's disease hinders the brain's ability to clear out a troublesome protein, a new study finds.


Researchers have known that people who carry the *e4* version of the gene *APOE* are at higher risk for Alzheimer's disease and are more likely to have cell-killing plaques in their brains than people who have the *e3* or *e2* versions. But it hasn't been clear whether people with the *e4* version made more of the plaque protein — called amyloid-beta — or if the stuff just stuck around in their brains longer.

Now researchers led by David Holtzman of Washington University

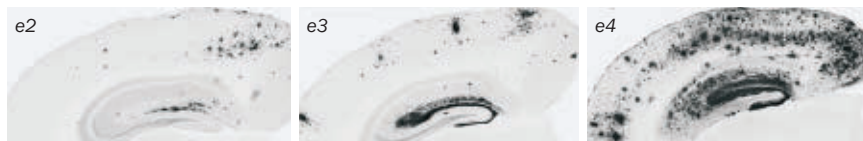
School of Medicine in St. Louis have directly measured levels of amyloid-beta in the brain fluid of mice. The measurements, reported in the June 29 *Science Translational Medicine*, show that mice with the *e4* version of *APOE* make amyloid-beta at the same rate and in the same amount as mice with different versions of the gene, but don't clear the protein

out of the brain as efficiently.

The study will probably draw more attention to the role amyloid-beta clearance plays in Alzheimer's disease, says neurobiologist Caleb Finch, codirector of the Alzheimer Disease Research Center at the University of Southern California.

It is not yet clear how different forms of the protein made by *APOE* govern clearance of amyloid-beta from the brain, says Joseph Castellano, a neuroscientist working in Holtzman's lab. "We don't understand that at all," he says. 

Plaque attack How much plaque (dark blotches) builds up in the brains of mice genetically engineered to get Alzheimer's disease depends on which version of the *APOE* gene the animals have. The *APOE e4* version is a risk factor for Alzheimer's disease in people and inhibits clearance of the plaque-forming protein from mice's brains (right).



New technique fixes DNA errors

Method allows direct repair of genetic typos in infant mice

By Tina Hesman Saey

A new type of gene therapy allows scientists to fix DNA defects directly. That's a potentially revolutionary improvement on present gene therapy techniques, which introduce working genes to cells — but not into the genetic library itself.

"This is a major leap of the technology," says John Rossi, a molecular geneticist at the Beckman Research Institute of City of Hope in Duarte, Calif.

Working with newborn mice, researchers led by Katherine High at the Children's Hospital of Philadelphia found that molecular editors called zinc finger nucleases can correct a genetic mutation that leads to the blood-clotting disorder hemophilia. Fixing a mistake

in the gene for blood coagulation factor IX allowed the animals to make about 3 percent to 7 percent of normal levels of the protein, High and her colleagues report online June 26 in *Nature*. Even such modest increases are therapeutically meaningful, High says. People who make about 5 percent of normal levels of the clotting factor have mild cases of hemophilia.

"I always say that someone with mild hemophilia can play on the college tennis team, but they cannot play on the football team," says High, a Howard Hughes Medical Institute investigator. By contrast, a person with severe hemophilia may develop bleeding in the knee just by sitting in a chair.

Current gene therapy uses viruses to deliver healthy copies of genes into cells. But because the viruses don't insert themselves into the cell's DNA, that sort of gene replacement therapy is not a permanent solution, Rossi says.

The new method repairs defective genes using zinc finger nucleases. These molecules are designed by researchers

to recognize a particular gene and then, working in pairs, make a cut in the DNA. The cell's own repair machinery then takes over, repairing the break and the typo using a healthy copy of the gene inserted by the researchers as a template.

Zinc finger nucleases have edited mistakes out of cells grown in the laboratory, but no one had previously reported success with correcting typos in an animal. The researchers don't yet know whether typos can be corrected in adult mice or in larger animals such as dogs and people. And the editing system doesn't fix the mistakes in a large proportion of cells, so the researchers would like to boost the correction rate. If the process can be optimized, it may provide a way to cure many different genetic diseases, High says.

Ultimately, gene repair might be the best choice for treating genetic diseases, but traditional gene therapy still has its place, High says. "I see no reason to put gene replacement therapy on hold while you try to refine this." ■

Body & Brain



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Certain foods pack on the pounds

French fries, soda among biggest causes of weight gain

By Nathan Seppa

If there was ever any suggestion that french fries are good for you, it's now dispelled in stark detail. An analysis of data from three lengthy surveys that assigns actual pounds of weight gain to foods finds that fries, sodas and several other guilty pleasures are among the most potent waist expanders.

On the bright side, researchers attribute weight loss to eating yogurt, fruits, nuts and vegetables. The report appears in the June 23 *New England Journal of Medicine*.

“Conventional wisdom often recommends ‘everything in moderation’ with a focus only on total calories consumed, rather than the quality of what is consumed,” says study coauthor Dariush Mozaffarian, a cardiologist at Harvard Medical School and Brigham and Women’s Hospital in Boston. “Our results demonstrate that the quality of the diet — the types of foods and beverages

that one consumes — are strongly linked to weight gain.”

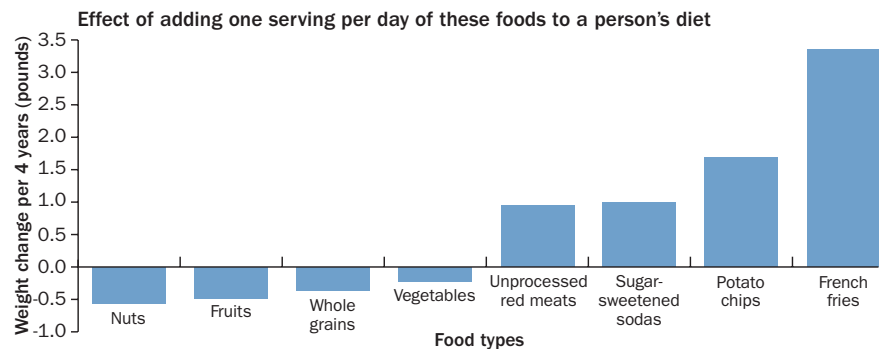
Mozaffarian and his colleagues combined data from three long-term surveys of middle-aged health professionals in the United States that were conducted from 1986 to 2006. The weight, diet and lifestyle information collected in those surveys, which included more than 22,000 men and nearly 100,000 women,

enabled the researchers to calculate an effect for specific foods.

Starting with each volunteer’s weight at the outset, the researchers monitored any gain or loss at four-year intervals. On average, participants had gained 3.35 pounds at each four-year point.

Potatoes stood out as a culprit. A single-serving bag of potato chips added to one’s daily intake tacked on 1.69 pounds over four years by this calculation. Boiled, mashed or baked potatoes added about half a pound, while french fries larded on 3.35 pounds. A single

Food fright If you are what you eat, then the term “couch potato” is remarkably apt. A study of more than 120,000 people gauged the effect of adding different foods to the diet. Adding potatoes and potato products boosted weight; adding fruits, vegetables and nuts to the diet shed pounds.



SOURCE: D. MOZAFFARIAN ET AL./NEJM 2011

Brain separates working memory

Hemispheres independent in mental version of RAM

By Laura Sanders

Like side-by-side computer RAM cards, the left and the right hemispheres of the brain store information separately, a new study in monkeys finds. The results help explain why people can remember only a handful of objects at one time and suggest that it may be possible to maximize mental performance by delivering information in equal doses to both sides of the brain, researchers report in the July 5 *Proceedings of the*

National Academy of Sciences.

On average, people can hold about four things in their working memory at once, such as the location of four cards in a game of Concentration. Scientists still don’t completely understand how the brain reaches this limit.

“Why can’t you think about 100 things simultaneously, or 50 things simultaneously? Why only four?” says study coauthor Earl Miller of MIT. “If we understand something about that, we’ll understand something very deep about how the brain represents information and how thoughts are made conscious.”

Miller and his colleagues tested two monkeys (which also have a four-item working memory capacity) in a simple task. First, the monkeys saw two to five colored squares flash on a computer

screen for less than a second. The screen went blank, and then the squares reappeared — but one was a different color. The monkeys were rewarded for spotting the change.

As the number of squares increased, the monkeys got worse at finding the color change. But Miller and his colleagues noticed a curious twist: Adding an extra square to the left side of the computer screen didn’t affect a monkey’s ability to remember squares on the right side of the screen, and vice versa.

Since the monkeys could track about two objects on each side of the screen, this means the magic number of four is really a sum: two objects tracked by each brain hemisphere.

While the monkeys were playing the square game, the researchers also

6.3
per 100,000

Global annual
venomous snake-
bite incidence

0.8
per 100,000

Venomous snake-
bite incidence,
North America


20.3
per 100,000

Venomous snake-
bite incidence,
central Africa


sugar-containing soft drink per day tacked on 1 pound every four years. Butter, refined grains, desserts, processed or red meats, fruit juice, fried food or foods containing trans fats added less than that.

Other foods seemed to lower weight. Adding a daily serving of yogurt knocked off nearly a pound over four years, while adding a serving of nuts or fruit was associated with a loss of about half a pound each. An extra serving of whole grains, vegetables or diet soft drinks reduced weight slightly.

Changes in intake of dairy products other than butter and yogurt, whether low-fat or not, appeared to have little effect on weight.

Specifying which foods may lessen or prevent weight gain is highly practical, says Christopher Gardner, a nutrition scientist at Stanford University who wasn't involved in this study. "When you choose one of these foods, you choose not to consume something else," he says. The strength of the study, he says, is that it demonstrates that "these are achievable differences because real, live people did them." 

eavesdropped on brain activity using electrodes, which showed a distinctive split in working memory performance. Packing one side of the screen with squares caused nerve cells to go haywire. But adding squares to the sparsely populated side of the screen caused little chaos.

This split-brain finding may lead to techniques for boosting working memory capacity, Miller says. Working memory ability reflects the thinking power that is measured by IQ tests, SAT scores and the ability to learn a second language, says neuroscientist Edward Vogel of the University of Oregon. "The more we understand about these basic capacity limits, the more that's going to tell us something deep about the core cognitive abilities that differ from individual to individual." 

Salve buys time after snakebite

Ointment slows venom's progress to vital organs

By Nadia Drake

Indiana Jones, intrepid cinematic archaeologist, is famously afraid of snakes. Perhaps he wouldn't need to be if he had an ointment recently tested by scientists in Australia. Quickly applying a nitric oxide-producing ointment near the bite site slows the spread of some venoms, including the notorious eastern brown snake's, the researchers report online June 26 in *Nature Medicine*.

"This treatment might make all the difference between dying on the road and getting to the hospital in time," says physician and tropical medicine specialist David Warrell of the University of Oxford, who was not involved with



Applying a nitric oxide-producing ointment right after being bitten by some poisonous snakes, including this eastern brown snake, can slow the transport of venom to the vital organs.

the study. Worldwide, snakebites cause about 100,000 deaths and 400,000 limb amputations each year.


Physiologist Dirk van Helden at the University of Newcastle in Australia and his colleagues showed that, in humans, applying a nitric oxide-producing ointment within one minute of a simulated snakebite slows the transit of injected tracer molecules. Foot-to-groin tracer travel times increased from an average of 13 minutes without the ointment to an average of 54 minutes with the ointment, when applied in a 5-centimeter-diameter circle just up the limb from the bite site.

The group also tested the effects of the cream on rats injected with venom from the eastern brown snake (*Pseudonaja textilis*), native to Australia. In rats slathered with ointment, symptoms of snakebite toxicity set in about 96 minutes after injection, compared with about 65 minutes in untreated animals.

The nitric oxide source in the ointment is nitroglycerin, the same compound used to treat angina. When applied to the body, the ointment releases microscopic amounts of nitric oxide gas, which sinks through the skin. There, the gas inhibits pumping of the lymphatic vessels — the primary roadways for molecules too big to squeeze through blood vessel walls and hitch a ride in the bloodstream.

But victims might be out of luck if bitten by a black mamba or cobra, since the ointment isn't effective against venom containing smaller toxic proteins capable of directly entering the bloodstream.

Another potential snag is the need for bite victims to be quick on the draw. The scientists applied ointment within 20 seconds of a snakebite in rats and within a minute in the human tracer tests.

Van Helden hypothesizes that a combination of ointment and pressure treatment might be the best way to slow the spread of snake venom. But "if I had the ointment in my backpack," he says, "that would be the first I'd put on." 

Atom & Cosmos

Brilliant beacon is a quasar too far

Light from early universe strains black hole formation theories

By Nadia Drake

Astronomers peering at the early universe have glimpsed the most distant quasar yet. Powered by a black hole of 2 billion solar masses, the quasar appears as it did 12.9 billion years ago, when the universe as humans know it was just beginning to emerge from the Big Bang.

The supermassive black hole is pulling enormous clumps of matter into its gravitational clutches. As a result, the quasar emits 60 trillion times as much light as the sun, an international team reports in the June 30 *Nature*.

The team identified the object from the U.K. Infrared Telescope's Infrared Deep Sky Survey, which probes 5 percent of the sky. Daniel Mortlock of Imperial College London, an author of the study, likens the process to panning for gold. "You see many shiny things in the infrared, but not all of them are nuggets," he says. "We got a big nugget this time."

Already, the uncharismatically named ULAS J1120+0641 has posed both clues and puzzles about the early universe.

The most distant known quasar emits 60 trillion times the light of the sun. This illustration shows the quasar enveloped in a reddish bubble produced when its energy cleaves hydrogen atoms.



"The surprising thing is that this object is right at the farthest possible distance we could see," Mortlock says. The object is so distant that, because of the time it took the quasar's light to reach Earth, astronomers are seeing it as it appeared just 770 million years after the Big Bang. While theorists had predicted quasars could form that soon after the Big Bang, none had anticipated seeing one so large in the embryonic universe.

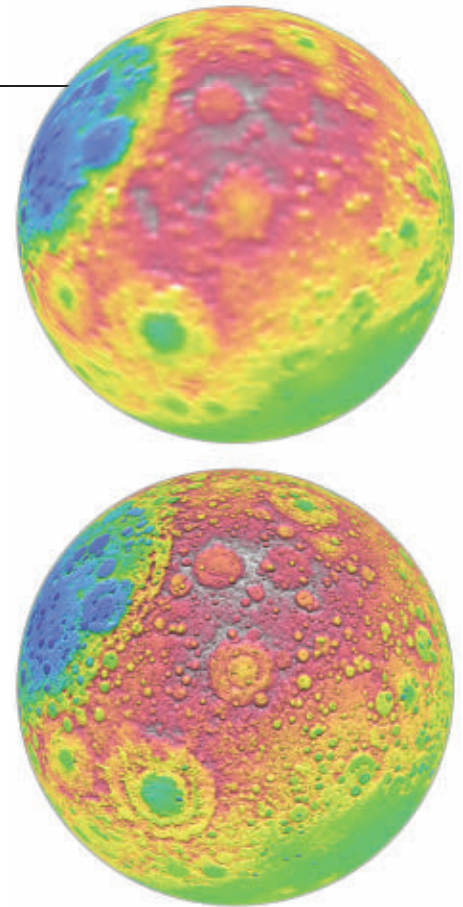
"It is like finding a 6-foot-tall child in kindergarten," says astrophysicist Marta Volonteri of the University of Michigan in Ann Arbor.

Prevailing theories suggest that black holes form either from the tiny, dense objects left behind after the explosive deaths of massive stars or from the direct collapse of cosmic gases. For the first theory to be correct, Volonteri says, ULAS J1120+0641 would have needed to begin growing before the Big Bang, suggesting that the direct collapse theory is better supported by the quasar's discovery.


Scientists think there are maybe 100 distant, bright objects like the newly discovered quasar sprinkled throughout the entire sky, and astrophysicist Avi Loeb of Harvard University says he hopes sky surveys will find more of them. These quasars, if they exist, could act as beacons of light to help guide astronomers studying the early universe.

The next steps include finding more of these giants in the early cosmic playground and studying the quasar's neighborhood using different wavelengths.

The discovery is intriguing, says Chris Willott of National Research Council Canada, but he adds some caution: "This could be one charmed place in the universe where things are going on very quickly. It's always dangerous if you base everything you know on one object." ■



Orbiter delivers sharp moon map

After orbiting the moon for two years, NASA's Lunar Reconnaissance Orbiter has beamed back more than 192 terabytes of data, scientists reported June 21. Those data include 4 billion measurements made by the orbiter's laser altimeter, which allowed scientists to construct an elevation map of the moon's pockmarked surface. The spacecraft's data show the lunar surface in far sharper resolution (bottom image) compared with maps made in 2005 by the U.S. Geological Survey's Unified Lunar Control Network (top). Flying about 50 kilometers above the cratered world, the 1,900-kilogram orbiter gathered data on the moon's temperature, composition and elusive far side, helping scientists identify shaded spots likely to hold frozen water and sunnier spots that could one day host a solar-powered moon base. — Nadia Drake 

TOP IMAGES: GODDARD SPACE FLIGHT CENTER SCIENCE VISUALIZATION STUDIO/NASA; LEFT: GEMINI OBSERVATORY

Earth

180
years

Average interval of big quakes on southern San Andreas fault

300
years

Time since last big quake on southern San Andreas fault

Floods may have triggered quakes

Geologists find evidence for natural disaster one-two punch

By Devin Powell

Before Hoover Dam was built, Colorado River floodwaters may have triggered small earthquakes in southern California. These tremors coincided with — and perhaps helped kick off — at least one big temblor on the nearby San Andreas fault, researchers report online June 26 in *Nature Geoscience*.

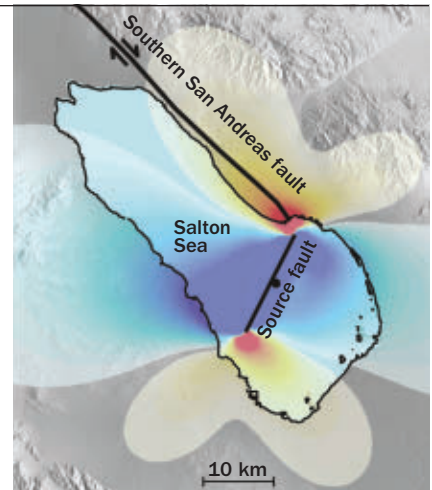
Daniel Brothers, a marine geologist at the U.S. Geological Survey Woods Hole Coastal and Marine Science Center in Massachusetts, and his colleagues mapped out several faults beneath California's Salton Sea, which sits at the southern tip of the San Andreas fault. The team also probed 1,200 years of the lake bed sediment, which records ancient

floods from the nearby Colorado River. Sharp tilts in the sediment revealed past motion on the faults, including four slips that happened at about the same time as earthquakes on the San Andreas.

At least four out of 17 small fault slips coincided with floods, though whether a quake or deluge came first is anyone's guess. In at least one case, a big quake on the San Andreas occurred at about the same time.

"Overall, it's a story that makes sense," says Ken Hudnut, a geophysicist at the USGS Pasadena, Calif., field office.

Lake Cahuilla, the Salton Sea's ancient predecessor, was up to six times as deep as the present-day lake. In the team's computer simulations, stress caused by the water's weight and pressure was



Double disaster A computer simulation suggests that the rupture of a fault beneath the Salton Sea could stress the nearby San Andreas (red indicates more stress).

enough to rupture the faults.

"The physics supports the idea that Lake Cahuilla would promote failures of these faults," says Brothers.

✓ Yes (Shock absorbers)
 ✓ Yes (Engine part)
 x No (Toy car)
 ✓ Yes (Wrench)
 ✓ Yes (Cables)
 ✓ Yes (Tail light)
 ✓ Yes (Yellow panel)
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Humans

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When numbers just don't add up

Kids with dyscalculia have trouble estimating quantities

By Bruce Bower

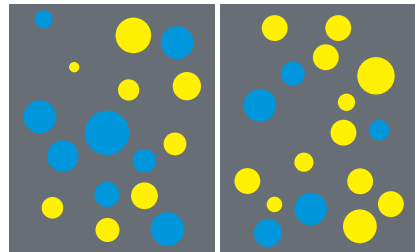
Math doesn't add up for some kids, and a weak number sense may be partly to blame.

An evolutionarily ancient ability to estimate quantities takes a big hit in children with severe math difficulties, say psychologist Michèle Mazzocco of the Kennedy Krieger Institute in Baltimore and her colleagues.

In contrast, below-average, average and superior math students estimate amounts comparably well, the researchers report in a paper published online June 16 in *Child Development*.

"It's possible that developmental routes to mathematical learning disability share a core deficit in numerical estimation," Mazzocco says.

Math learning disability, or dyscalculia, affects an estimated 5 to 7 percent of schoolchildren. Dyscalculia is defined



In one test, ninth-graders with dyscalculia had trouble determining whether more blue or yellow circles were present in arrays of dots briefly flashed on a computer screen.

as consistent, extremely low scores on math achievement tests. Causes of this problem remain poorly understood.

Mazzocco's new findings coincide with results from an ongoing study of more than 300 Missouri schoolchildren tested annually since kindergarten. By third grade, kids with a math learning disability display several types of thinking hitches, says psychologist and investigation director David Geary of the University of Missouri in Columbia. In some cases of dyscalculia, youngsters have trouble gauging whether one set of items is more numerous than another. Others can't estimate the number of

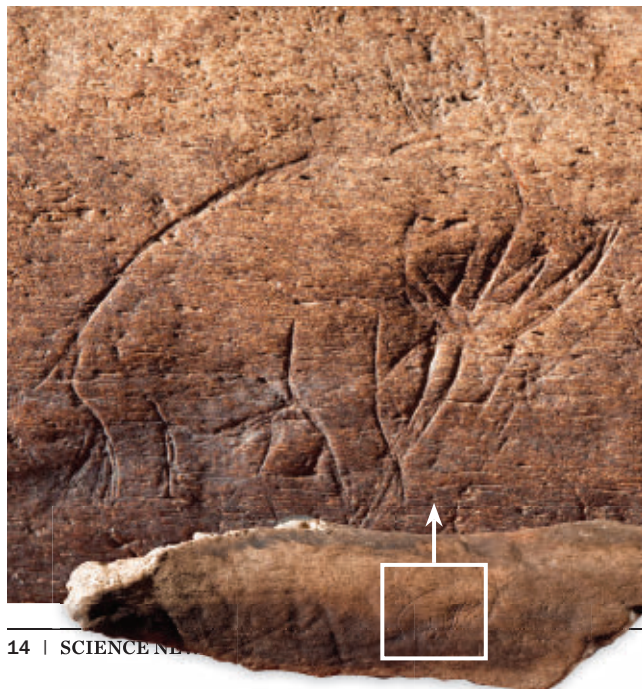
items that they briefly see, quickly forget verbal information, can't hold related pieces of information in mind or struggle in all of these areas.

"We're trying to isolate different cognitive deficits that can result in math learning disability," Geary says.

Mazzocco's group studied 71 ninth-graders whose math abilities had been tested since kindergarten. Students completed two quantity-estimation tasks. In one series of trials, participants saw an array of blue and yellow dots flash for a fraction of a second on a computer screen and had to indicate whether more blue or yellow dots had appeared. In other trials, students saw nine, 12 or 15 yellow dots flash on a screen and estimated how many dots were shown.

Students with dyscalculia made substantially more mistakes comparing and estimating quantities than their peers. That disparity remained after accounting for reading and memory problems among kids with dyscalculia.

Mazzocco and her colleagues have found that the ability to estimate approximate quantities without counting generally improves during childhood and is related to math achievement. ■



Mammoth etching found

An engraving of an Ice Age mammoth on a fossil bone could be the oldest drawing in the Americas. Mammoths disappeared from eastern North America 13,000 years ago, so the etching must be at least that old, says a team led by anthropologist Robert Speakman of the Smithsonian Institution's Museum Conservation Institute in Suitland, Md. The team's analyses indicate that the bone and etching are ancient. The bone itself, found by an amateur fossil hunter in Florida, comes from a mammoth, mastodon or giant sloth. Speakman's team does a "reasonable job" of showing that the engraving is genuine, says archaeologist David Meltzer of Southern Methodist University in Dallas. But the find can't be dubbed the oldest American art without direct dating evidence, Meltzer says. Replacement of the original bone by minerals prevents DNA extraction or radiocarbon dating, the scientists explain online June 12 in the *Journal of Archaeological Science*. — Bruce Bower

Pioneering audiologist invents "reading glasses" for your ears.

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*Thank-you.
— G. Austin, MA*

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Environment



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Male mice less macho with BPA

Early exposures can erase some masculine behavior

By Janet Raloff

An ingredient in many clear plastics also renders some gender-linked behaviors plastic, at least in mice. Two new studies link feminized behaviors in adult males with exposures during development to bisphenol A, a weak estrogen-mimicking chemical. In one study, some behaviors in BPA-exposed females morphed into features characteristic of males.

The findings come from laboratory studies conducted in different species of mice. Each experiment also exposed animals to the chemical at a different time during development — one from the womb through weaning, the other during the rodent equivalent of adolescence and early adulthood. The trials therefore identify different periods during which the brain appears vulnerable to pollutants that mimic or alter the activity of sex hormones.

Because early BPA exposures left no

lasting changes in sex hormone levels, the authors of each study note, the behavioral changes observed in adulthood probably trace to an earlier rewiring of brain circuitry — most likely in an area known as the hippocampus.

Cheryl Rosenfeld of the University of Missouri in Columbia and her colleagues added BPA to the chow they fed to pregnant deer mice. BPA concentrations in the moms peaked at around 9 nanograms per milliliter, Rosenfeld says, “which is in the range of what’s been measured in humans.”


Tests in offspring of the treated animals evaluated spatial navigational abilities — something at which males normally excel — and susceptibility to fear or anxiety in new or unprotected spaces. Spatial learning abilities and exploratory behaviors were severely compromised in males that encountered early BPA doses, relative to unexposed males, Rosenfeld’s team reports online June 27 in the *Proceedings of the National Academy of Sciences*.

For instance, a male released into a pen with many portals will seek the exit that leads to its own cage. Unexposed males quickly learned to find their exit. BPA-exposed males, by contrast, tended

to take random paths or serially visit all exits, often without committing to any.

In that study, BPA did not affect female behavior, but females found BPA-exposed males less attractive than unexposed males. Rosenfeld is investigating cues, such as scents or behaviors, the BPA-exposed males might be giving off.

Because male mice need to explore large areas in search of females, BPA might jeopardize a guy’s ability to find a mate, notes Laura Vandenberg of Tufts University in Medford, Mass., who did not take part in the research. That the gals prefer unexposed males over those exposed to BPA in the womb “is shocking,” she says, and provides further evidence that BPA “can interfere with the mating process.”

In a second study, researchers at Zhejiang Normal University in Jinhua, China detail impaired spatial navigational abilities and exploratory behaviors in standard male lab mice that had been exposed to low levels of BPA beginning in adolescence. These later exposures also affected females, the researchers report online in *Neuropharmacology*. For instance, emboldened BPA-exposed females were as willing to explore open areas as males typically are. 



Lionfish meet their match

Initially all but ignored by native predators, the beautiful but venomous lionfish (left) — an Asian native — has spread widely and rapidly throughout eastern U.S. waters and the Caribbean since being introduced through the aquarium trade. However, an international research team now finds that lionfish densities are amazingly low in the Bahamas’ Exuma Cays Land and Sea Park, apparently because the invasive fish has become a favored lunch of the native grouper. As a result of a 20-year fishing ban in the park’s waters, huge groupers thrive there, the scientists report June 23 in *PLoS ONE*. The researchers argue that the situation illustrates a need for fishing controls that would aid populations of large groupers, one of the few natives with a proven appetite for lionfish. Some lionfish escaped into the wild in 1992 when Hurricane Andrew broke an aquarium in a Miami home. Scientists suspect many additional introductions were deliberate. — Janet Raloff

679
million tons | China's coal
consumption
in 1980

1,413
million tons | China's coal
consumption
in 2002

2,893
million tons | China's coal
consumption
in 2007

Sulfur stalled surface temperature

Coal emissions explain why warming stopped for a decade

By Nadia Drake

A new study demonstrates why global surface temperatures defied a decades-long trend and didn't continue to rise between 1998 and 2008: Pollution-spewing, coal-burning power plants in Asia, while emitting warming greenhouse gases, simultaneously sent cooling sulfur particles into the atmosphere.

During that decade when temps held steady — sometimes cited as evidence against global warming — these Asian emissions mostly balanced one another and dampened the natural cooling effects expected from cycles of the sun and ocean.

A team of scientists led by Boston University's Robert Kaufmann analyzed factors contributing to global surface temperature, including human-caused emissions, the 11-year solar cycle and a shift from warming El Niño to cooling La Niña climate patterns. Without human input, average temperatures would have cooled, based on the La Niña shift and decreasing solar radiation, the researchers report online July 5 in the *Proceedings of the National Academy of Sciences*.

After simulating temperature changes expected over the decade based on these factors, the researchers identified the smoking gun behind steady temperatures: sulfur particles belched into the atmosphere by coal-burning power plants. Sulfur aerosols reflect light back into space and counteract the warming effects of greenhouse gases.

"This looks like a very solid, careful statistical analysis of the factors influencing recent global temperature changes," says climate scientist Michael E. Mann of Pennsylvania State University, who was not involved in the study.

Most of the increase in sulfur emissions came from China, where coal consumption more than doubled between 2002 and 2007, accounting for 77 percent of the rise in coal use worldwide, the scientists report. During that period, Kaufmann says, global sulfur emissions increased by 26 percent. From 1998 to 2008, greenhouse gas and sulfur emissions effectively canceled each other out.


"You wouldn't want to increase the amount of junk in the air to decrease ... warming."

GAVIN SCHMIDT

"Humans do two things to the planet," Kaufmann says. "They warm it by emitting greenhouse gases like carbon dioxide and methane, and they cool it by emitting these sulfur aerosols."

Sending sulfur into the air isn't entirely helpful, though. In addition to causing respiratory problems, sulfur aerosols combine with water vapor to form acid rain. "You wouldn't want to increase the amount of junk in the air to decrease the effects of global warming," cautions climate scientist Gavin Schmidt of NASA's Goddard Institute for Space Studies in New York City.

China has begun using scrubbers at its coal-burning facilities to reduce sulfur emissions, efforts similar to those in the United States after passage of the Clean Air Act in 1970. When sulfur emissions are reduced, "what you will see in the short term is a relative rapid rise in temperature, because you have taken away the brake," says Caspar Ammann, a climate scientist at the National Center for Atmospheric Research in Boulder, Colo.

Judith Curry of Georgia Tech in Atlanta notes that decadal oscillations in ocean currents could also explain the observed stall in temperature rise. But Kaufmann argues that when sulfur is removed from the analysis, the model falls apart. "Only sulfur aerosols can explain the recent pattern," he says. 

NEWS BRIEFS

Planes punch sky holes

Airplane takeoffs and landings may be affecting the weather around them. When a plane flies through a cloud containing supercooled water, which is liquid despite being below its freezing point, the plane triggers the formation of ice crystals that fall out as snow or rain. Such supercooled clouds might exist around airports up to 6 percent of the time, scientists led by Andrew Heymsfield of the National Center for Atmospheric Research in Boulder, Colo., report in the July 1 *Science*.

—Alexandra Witze

Glacier having a meltdown

Ocean currents are scouring Antarctica's floating Pine Island Glacier from below, causing it to melt ever faster. American and British scientists measured the temperature and saltiness of water around the glacier and found that since 1994 the amount of meltwater from the ice has increased by 50 percent. Pine Island is the fastest-shrinking glacier in Antarctica. The team reports the findings online June 26 in *Nature Geoscience*. —Alexandra Witze

Plastics link to diabetes

Women exposed to relatively high amounts of phthalates, used in plastics and as solvents, are more likely to be diabetic, a study in Mexico finds. Although previous studies have linked phthalates with risk of obesity—itsself a risk factor for diabetes—the newly identified association appears to be independent of obesity, the researchers report online June 21 in *Environmental Research*.

—Janet Raloff



Tiny device runs on jitters and jolts

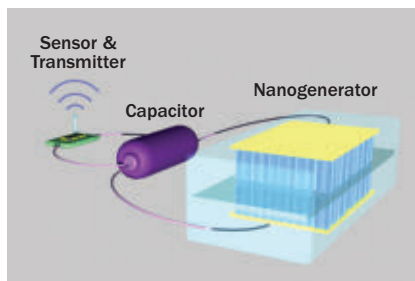
New sensor gets power from motion to send wireless signals

By Rachel Ehrenberg

Imagine charging your iPod just by shouting into it, or powering a blood-glucose monitor with your pulse. Such technologies aren't far off: In the latest rendition of tiny, energy-scavenging devices, scientists have developed a sensor that produces enough electrical charge when flexed mechanically to transmit a wireless signal several meters.

With further improvements, the new device might be part of an array of sensors used to monitor the strength of a bridge, for example, while powering itself with the vibration of trucks rumbling overhead, says Zhong Lin Wang of Georgia Tech, who led the new work.

The device is powered by zinc oxide nanowires that generate charge when bent, a property found in some crystals such as quartz. Such piezoelectric materials have already found their way into everyday devices — some cars, for example, have piezoelectric crash sensors in the air bag wiring.



Flex your power When bent or flexed, the zinc oxide nanowires in this little generator produce enough electrical charge to power a sensor and wireless transmitter, no batteries necessary. Such sensors might be used to monitor the integrity of buildings or bridges.

Wang and his colleagues put layers of piezoelectric nanowires on either side of a flexible piece of polyester and sandwiched that between two metal electrodes. Then the researchers wired the device, which is smaller than a penny, to a capacitor connected to a radio transmitter. When flexed between two fingers, the nanogenerator produces charge and stores it in the capacitor. The device has an output of about 10 volts and an output

current of more than 0.6 microamps, Wang and his team report in the June 8 *Nano Letters*. That's enough to send out a wireless signal every five minutes that's detectable more than 10 meters away, Wang says.

Energy scavenging isn't new, of course: Windmills, waterwheels and solar panels all capture power from the environment. Today scientists are refining and optimizing different strategies and materials, trying to figure out which energy-harnessing devices work best where, says electrical engineer Joseph Paradiso of MIT.

"I'm sure there's a niche for this," he says of the new research.

Other researchers are focused on piezoelectric devices that use body power. A team led by Princeton University's Michael McAlpine recently reported creating nanoribbons that might harvest the motion of lungs breathing to charge a pacemaker battery. Nanofibers that generate charge when pulled and twisted could eventually be spun into clothes for powering personal electronic devices with routine movement. And researchers in Korea are harnessing the voice's vibrational energy to charge cell phones. ■

NEWS BRIEFS

Electrifying ink

A new pen that writes with electricity-conducting ink can be used to make flexible electronic devices. Researchers from the University of Illinois at Urbana-Champaign and Lawrence Livermore National Laboratory created a silver-nanoparticle ink that smoothly flows through a rollerball pen tip without leaking, skipping or clogging. The team drew electrodes on ordinary office paper and, with a few other ingredients, used the paper to create a flexible sheet of light-emitting diodes and a 3-D radio-frequency antenna. Such a strategy could be used to make paper-based batteries and medical

diagnostic devices, the researchers report online June 20 in *Advanced Materials*. — Rachel Ehrenberg

Superelastics go extreme

Superelastic alloys under high stress have an unrivaled ability to snap back into shape, and now one can also take the heat. The new material remains superelastic over a broad range of temperatures (–196° to 240° Celsius) and can be used in cars, planes, spacecraft or in any environment subject to extremely high and low temperatures. Because the new material is made of iron and other common metals, large quantities could be incorporated into buildings to dampen vibrations caused

by earthquakes, researchers at Tohoku University in Japan report in the July 1 *Science*. — Devin Powell

Molecules in knots

New knots fashioned from molecules would leave even a Boy Scout tongue-tied. Researchers in England and Slovenia grabbed onto stringy surface defects and looped them around spherical particles in a liquid crystal. The team used laser tweezers to cut, manipulate and fuse the loops, creating interlinked trefoils, Stars of David and other shapes. Such knots might be useful for creating new soft materials or for studying how DNA tangles, the researchers report in the July 1 *Science*. — Devin Powell

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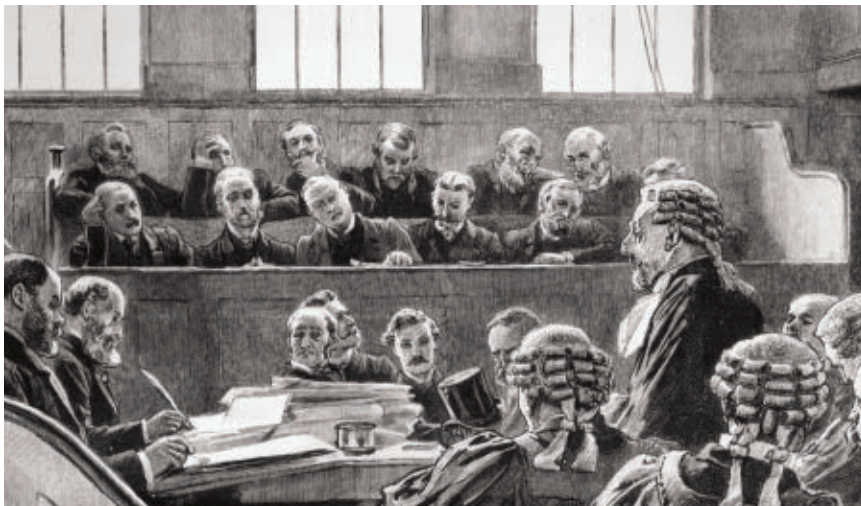
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An online database offers access to more than 200 years' worth of proceedings from the Old Bailey courthouse. A case from 1891 is depicted here.

such stories and represents the cutting edge of what has come to be known over the last decade as the digital humanities. Historians and other scholars trained for contemplation rather than computation increasingly plumb collections of newspapers, books, music and maps, as well as other information troves.

Eight interdisciplinary groups of digital humanists, winners of a grant competition organized by the National Endowment for the Humanities, convened in June in Washington, D.C., where researchers working with Old Bailey's digitized archive reported their findings.

"The humanities attempt to understand people's lived experience," says team codirector Dan Cohen, a historian at George Mason University in Fairfax, Va. "We don't want to quantify everything, but our toolkit now includes powerful techniques for probing data."

Innocence lost

Those techniques include two software programs that allowed Cohen and colleagues to search the 127-million-word Old Bailey trial record for criminal trends and language patterns.

When the team used digital court transcripts to calculate trial lengths in words for guilty and not-guilty verdicts over 239 years, an unexpected finding popped out. Trial lengths diverged around 1825, for offenses ranging from murder to disturbances of the peace. One set of trials maintained a previous drift toward lengthy proceedings, whereas a second set of hearings concluded quickly. Further analysis determined that, also around 1825, guilty pleas rapidly increased in number.

Before 1825, nearly all defendants pleaded innocent and sought a trial by their peers, historian and team member Tim Hitchcock of the University of Hertfordshire in England reported at the meeting. Trials consisting of several thousand words or more were common.

Crime's digital past

Computer science makes history in a Victorian-era courthouse **By Bruce Bower**

Henry Howard was in big trouble. Down on his luck, the family man stood in the dock of London's Old Bailey courthouse facing a forgery charge. A Bank of Scotland clerk had just confirmed that a month earlier, on March 14, 1879, Howard bought furniture with a check belonging to someone else. He signed the check with James McDonald's name.

With the defense counsel's blessing, Howard abruptly switched his plea from not guilty to guilty. He begged for mercy to a row of judges. Too late: A forgery conviction bought Howard a year in prison.

Little did the litigated Londoner know that, more than a century later, tech-savvy scholars would consult his case and those of a quarter of a million other Old Bailey defendants. With sophisticated software, historians, philosophers and computer scientists are today probing digitized records of the more than

197,000 Old Bailey trials — some with two or more defendants — that took place from 1674 to 1913.

Predominantly working-class citizens trooped into the Old Bailey courthouse accused of murder, rape, extortion and many other misdeeds. And the legal procedures developed at the London facility heavily influenced criminal law in Colonial America. Among other insights into the history of crime and punishment, digital searches of Old Bailey court records offer a glimpse of the rapid rise of plea bargaining and of a growing tendency within the legal system to treat marriages as partnerships of love, not convenience.

"The Old Bailey, like the Naked City, has 8 million stories," says English professor and digital humanist Stephen Ramsay of the University of Nebraska-Lincoln.

Carving up a massive information resource with the help of digital tools and scientific methods offers a way to retrieve

After 1825, numbers of guilty pleas soared, accounting for one-third of all cases by 1850 and 40 percent by 1913. Many of these trials contained no more than 100 words. Trial records showed that defense lawyers increasingly encouraged clients to plead guilty during the second quarter of the 19th century.

"Finding a revolution in legal practice at that time came as a complete surprise," Hitchcock says.

Scholars have noted various reasons for plea bargaining's popularity, including the gradual rise of a powerful legal profession and growing concerns about prison overcrowding. But the timing of a transition from jury trials run by judges to out-of-court deals arranged by lawyers has attracted virtually no attention.

Love and marriages

Another tale from the Old Bailey concerns the growing independence of Victorian-era women, as witnessed by records from bigamy trials.

Roughly equal numbers of male and female defendants appeared in court during the 1700s, Cohen said at the meeting. But adjudicated crime became a man's world during the next century, when eight times as many males as females appeared as defendants. As part of that trend, the number of bigamy cases brought against men progressively increased after 1820, regularly reaching 20 to 30 cases annually by the end of the century.

At the time, marriages were often arranged or instigated by male suitors or their families, and men were expected to rule over their wives. Legal divorces were difficult and expensive to obtain, but many people accepted informally agreed upon divorces as valid.

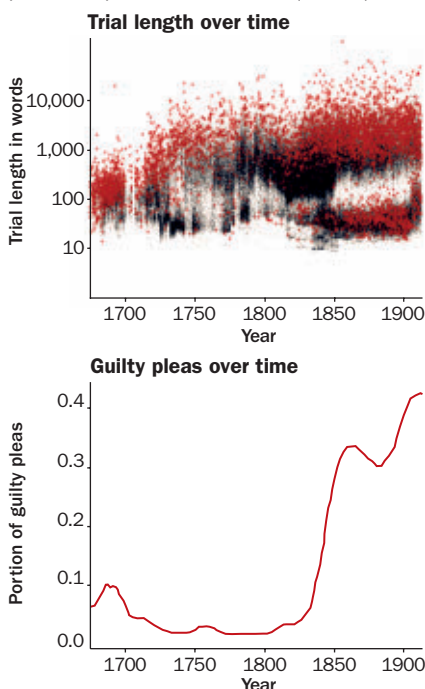
Given that spouses could lose contact for months or years and legal records of past marital unions often could not be located, perhaps it's not surprising that Victorian-era men increasingly got hauled into court facing accusations of having two or more wives. Unexpectedly, though, the number of cases of female bigamy rose from virtually nil to an average of six or seven annually after 1880.

"It's not clear why female bigamy cases increased at that time, but Victorian England witnessed cultural changes in the latitude granted women to control their lives," Cohen says.

To test the possibility that in the late 1800s a rising number of frustrated wives started seeking new husbands based on mutual affection, Cohen and colleagues combed through trial records to determine frequencies of different adjectives applied to the word *marriage* over time. The big winner among marriage modifiers as the Victorian era played out: *loveless*. Other words that increasingly described marriages in Old Bailey trials included *clandestine*, *forbidden*, *foreign*, *fruitless* and *hasty*.

That's only suggestive evidence for a new strain of female independence, Cohen cautions. But it's striking, he adds, that the few early female bigamy trials found in the data included long, nasty attacks on defendants' characters by prosecutors and judges. Toward the

Let's cut a deal Researchers have found that around 1825 some trial transcripts continued their trend toward lengthening while others became much shorter (top, trials involving killing are in red). The change has been linked to a concurrent increase in the number of guilty pleas as a portion of all verdicts (bottom).



SOURCE: DATA MINING WITH CRIMINAL INTENT TEAM

end of the 19th century, women accused of having two husbands received quick trials and little legal grief.

"Female bigamy trials went from drawn-out cases where women were incredibly disparaged to slap-on-the-wrist verdicts," Cohen says.

History's future

Cohen and his colleagues know that many humanities scholars hold digital humanists in as low esteem as Old Bailey prosecutors once held women accused of bigamy. That's certainly true of historians, in Hitchcock's view. "About 90 percent of them sit quietly in an archive for a decade and then write a book with their names printed as large as possible on the cover," Hitchcock says. In their world, data-crunching makes rude noises with no apparent historical meaning.

Change is brewing, though. An analysis of the frequency with which different words appeared in more than 5 million books in Google's digital archive has yielded insights into language changes and other cultural trends and attracted much interest (*SN Online: 12/16/10*). Harvard biologist Jean-Baptiste Michel and bioengineer Erez Lieberman-Aiden, who conducted the analysis, call such attempts to use scientific methods to explore questions in the humanities "culturomics."

But trends identified in huge databases, such as a link between increases in female bigamy cases and marriages described as *loveless* in Victorian England, require confirmation with independent lines of evidence, Michel and Lieberman-Aiden cautioned in a joint e-mail.

Cohen plans to compare cultural trends gleaned from Google's digital book bin with Old Bailey findings. Hitchcock wants to construct a thief's-eye view of Victorian London from court records, charting how often various goods were stolen during the 1700s and 1800s.

Somewhere Henry Howard, foiled, furniture-seeking forger of stolen checks, is smiling. ■

Explore more

■ To search the Old Bailey digital archive, visit www.oldbaileyonline.org

Residents of the brain

Scientists turn up startling diversity among nerve cells

By Laura Sanders

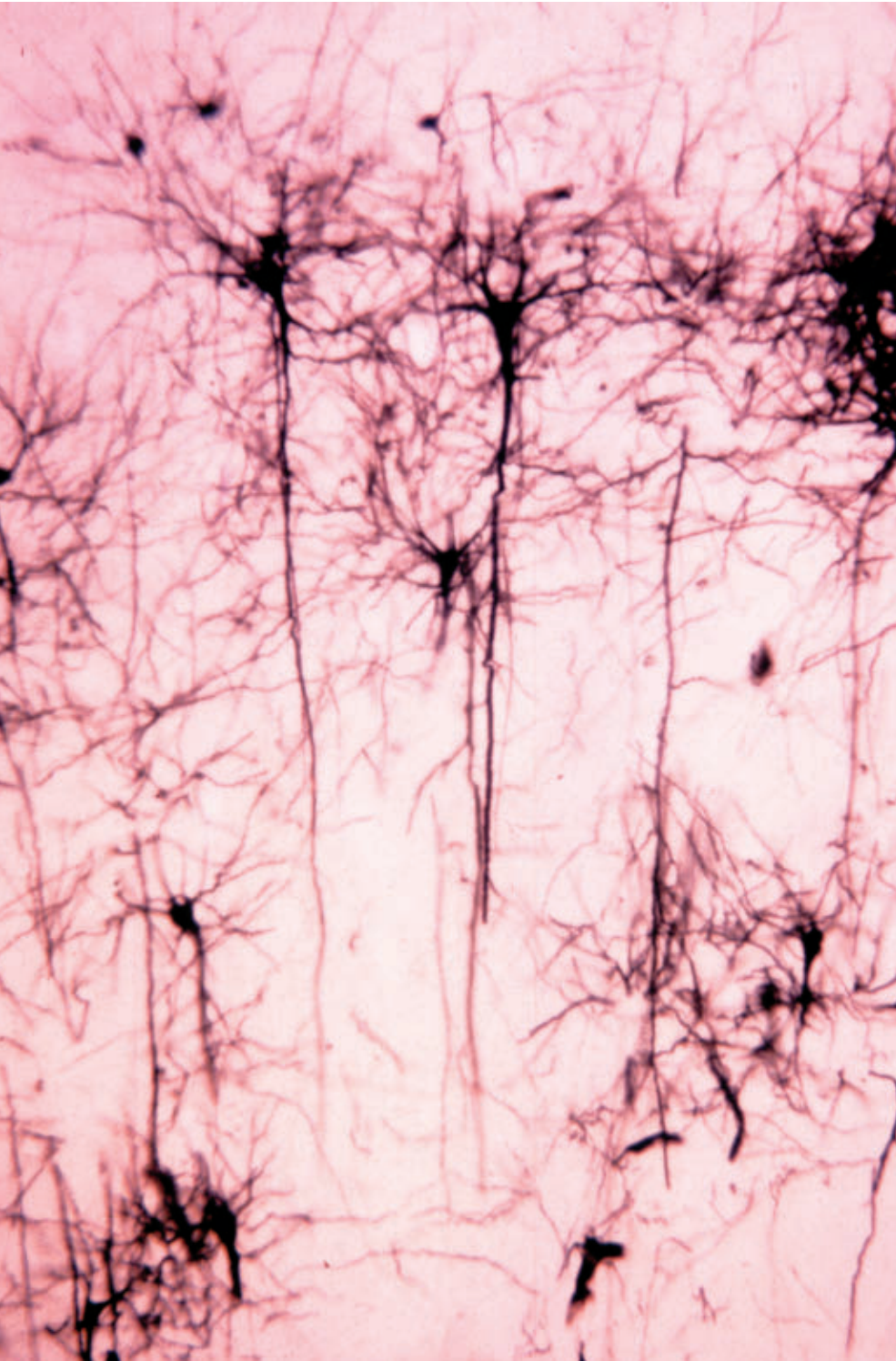
Peer out the window of a plane landing at LaGuardia Airport, and the tiny people scurrying around the streets of New York City all look the same. But take a stroll down Fifth Avenue and a new view emerges: Up close, New Yorkers are very different.

A street view of the brain also reveals a new perspective: No two cells are the same. Zoom in, and the brain's wrinkly, pinkish-gray exterior becomes a motley collection of billions of cells, each with personalized quirks and idiosyncrasies.

Powerful new techniques are giving researchers a glimpse of this staggering diversity—especially among nerve cells, the brain's information brokers. Even nerve cells presumed to do the same job come in a range of shapes and sizes and display a host of behaviors, sending their electrical messages in unpredictable ways, new studies reveal. The closer scientists scrutinize nerve cells, called neurons, the more differences turn up.

This cellular menagerie has left researchers puzzling over how best to categorize what neuroscientist Rafael Yuste of Columbia University calls these “living creatures.” So far, systematic methods are lacking. “Even after 100 years of research, we have no clue how many classes of neurons there are,” says Yuste, a Howard Hughes Medical Institute researcher. He and other scientists are developing new algorithms to automate neuron classification, in the hope of someday compiling

By classifying neurons based on shape and behavior, scientists may get a handle on which cells do what in the brain.



a standard “parts list” of the brain.

While some scientists are hard at work categorizing all these different cells, others are thinking about what such diversity means for living, breathing animals. New results suggest, for instance, that a population of nerve cells in which individual responses to an electrical poke differ can process more information than a group in which responses are the same. Others think that variety might help the brain cope with a changing environment.

Accounting for all of the individual brain components — a task as daunting as finding out every New Yorker’s favorite color, credit score and whether they cry at sad movies — isn’t just a tedious sorting job. A deeper knowledge of the brain’s inhabitants might lead to new treatments for brain-related disorders. If particular cells are more vulnerable to diseases such as dementia, schizophrenia and autism, therapies that protect or target these cell populations may be effective. More broadly, knowing who is doing what in the brain will help scientists understand the inner workings of the impossibly complex three-pound hunk of flesh that sits in the skull.

Brain census

Yuste is a collector. Instead of Broadway ticket stubs or rare butterflies, he and his colleagues sift through nerve cells in the brain, meticulously cataloging each cell’s appearance, behavior and habitat. Yuste believes that before scientists can understand the boroughs of the brain, they must know who lives there. “People

like us are interested in studying how the brain works by taking it apart,” he says.

Such efforts have described what appears to be a brain teeming with different groups of neurons. By virtue of their job description, these chief information officers have a message-sending axon and message-receiving dendrites, but that’s about where the similarities end.

Consider the pine needle–like extensions of granule neurons, which help memories form deep in the brain; the behemoth, feathery Purkinje neurons that coordinate body movements; and the twinkly stellate interneurons that help transmit visual signals.

In the past, such cell groups were uncovered by careful observation followed by whimsical naming. (How else to explain the “chandelier neuron”?) Yet this hodgepodge approach can go only so far. “What people have done traditionally is make up classifications,” Yuste says. “They look at neurons and say, ‘Oh, this neuron looks different from this other neuron.’ So they call this neuron class A and that neuron class B. This has led nowhere.”

He and his colleagues advocate a more systematic way. So far, the team has compiled descriptions of the traits of about 1,000 individual neurons. With informative descriptions available, computer algorithms and statistical tests put these cells into more orderly — and meaningful — classes. Like sophisticated coin sorters, these algorithms can consider loads of different neuron measurements, everything from body size and branch

pattern to how fast electrical messages are sent. The team is currently testing computer-based sorting programs in the hopes that they will be less capricious than a single person’s eyeballs.

Recently, Yuste and colleagues used such methods to identify two new “subtypes” of cells called interneurons in the mouse neocortex, the outer layer of the brain that controls, among other things, sensory perception. In the study, researchers led by Laura McGarry of Columbia reconstructed the sizes and shapes of 59 individual neurons, and also characterized the electrical pulses that the neurons use to communicate among themselves. This careful scrutiny resulted in a long list of properties, which was then fed into a computer. An algorithm divvied up the 59 neurons into three groups, two of which had never before been described, the team reported last year in *Frontiers in Neural Circuits*.

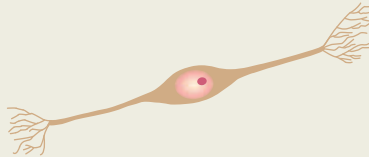
Cells belonging to the third subgroup, called Martinotti cells, had far-reaching and elaborate branching patterns, while cells in the two new subgroups seemed to be less spread out, McGarry says. The new groups showed subtle differences in the way they pass information. More experiments are needed to see whether this signal-sending variation is important.

Neuroscientist Kristin Baldwin is looking not at signals themselves, but at the precise shape of the long, spidery axons that send them. Baldwin, of the Scripps Research Institute in La Jolla, Calif., and her colleagues figured out a way to label individual mouse neurons with

Current classes Neuroscientists catalog nerve cells in many ways. One simple distinction is to sort neurons structurally by the number of long, thin extensions that send and receive messages from other cells. Though helpful, these groups represent the very tip of the classification iceberg. Scientists are finding vast diversity among neurons in the brain and are trying to make sense of what the differences mean.



Unipolar neurons have just one long projection that carries information. One job of these neurons is to collect sensory information from the skin and send the message to the brain.



Bipolar neurons have one message-receiving dendrite and one message-sending axon. Bipolar neurons in the eye collect information from rods or cones and pass it along to other nerve cells.



Multipolar neurons have one axon and many dendrites, which collect information from lots of different places. This class includes interneurons, which carry signals within the brain and spinal cord.

molecules that serve as beacons, glowing brightly when hit with particular wavelengths of light. Not that it was easy. Following the projections of a single nerve cell initially took about six weeks.

The particular neurons Baldwin studies, called mitral cells, are smell gobetweens, carrying odor information from scent-detecting cells in the nose to higher brain regions. Because mitral cells are situated close to each other and have the same job description, Baldwin expected their info-sending axons to look similar. Instead, the location, shape and numbers of axon branches appear very different from neuron to neuron, the team reported in the April 14 *Nature*. Preliminary studies suggest that these cells are in fact transmitting information to very different targets in the brain. Baldwin and her colleagues would next like to trace mitral cells into the amygdala, a brain region involved in emotion, to see what the axons look like there.

Staring at the shapes of single neurons has convinced Baldwin that “the harder you try to find two neurons that are the same, the more difficult it becomes.” The true diversity of the brain may be greater than anyone anticipated, she says.

Information overload

It was the bizarrely unpredictable and diverse behavior of mitral cells that alerted Nathan Urban to the possibility that variety might help the brain do its

job. Urban’s tip-off came from working with postdoc Krishnan Padmanabhan, who was learning how to record the electrical activity of these mouse neurons.

Urban remembers Padmanabhan coming into his office at Carnegie Mellon University in Pittsburgh saying, “I think I did something wrong. The cells’ responses look different today.” As someone who had studied those cells for years, Urban could reassure his colleague, saying, “No, it’s OK. Sometimes they look like that.” When Padmanabhan came back the next day with totally different data, Urban reassured him again: “Yeah, sometimes they look like that, too.”

This constant barrage of variation got Urban wondering whether there was an important brain principle at work. Maybe this variety results because the brain isn’t able to make identical neurons, Urban remembers thinking. But then again, maybe there’s something useful about having a wide repertoire of behavior in this neuron class.

“When we started thinking about if this was a feature rather than a bug, that’s when we started to get really excited about it,” Urban says.

A group of neurons that respond differently to the exact same input — in this case, a slight electrical jolt calibrated to be exactly the same for each cell — can actually transmit more information than cells that all respond exactly the same way. In their study, Padmanabhan and Urban

converted cells’ electrical responses into binary information, a series of 0s and 1s. Cell populations with diverse responses could carry twice as much information as cells that all behaved the same, the team reported last October in *Nature Neuroscience*. The results suggest that a varied group of eight of these smell-related cells could carry about 24.5 bits of information per sniff, while a group of eight cells that all responded in concert could carry only about 12.6 bits.

“This is a new idea, really,” Urban says, “that within what would normally be considered to be one class of cells, there might be variation that is useful to the system, to the organism.”

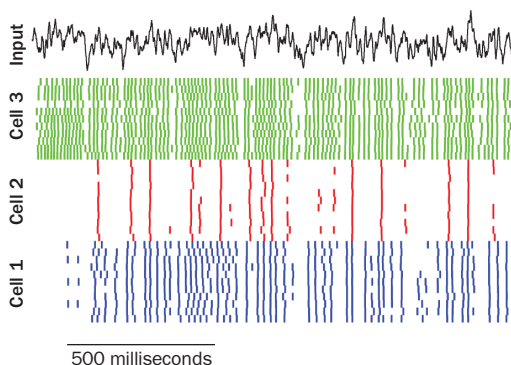
Instead of just speculating about the function of diversity, Urban and his colleagues are testing it by simulating virtual cohorts of neurons. Tweaking the degrees of variation has serious consequences for the group’s behavior, Urban and his team reported February 25 at the Computational and Systems Neuroscience Meeting in Salt Lake City.

“When the neurons are very similar to each other, you enter states where all the neurons are doing the same thing, and that’s useless,” Urban says. “If you have all the neurons in your brain doing the same thing, you’re unconscious or you’re dead. That’s not a desired state.”

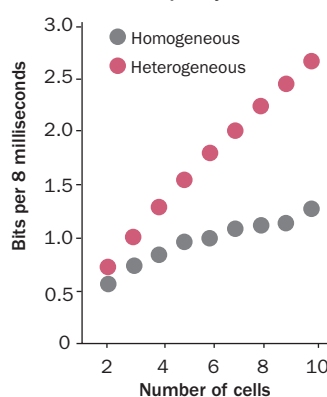
By playing with these models, Urban and his colleagues have come to view diversity as a commodity, something that’s probably precisely tuned to lend a hand to whatever task needs doing. They are looking to other brain regions, such as the memory-encoding hippocampus, for signs that diversity is a universal perk.

Diversity bonus Despite receiving an identical input (black line, below), three different smell-related neurons show different responses (activity in color). One research team has found that cell populations with such heterogeneous responses can carry twice as much information as a homogeneous group of the same size (right).

Three neurons’ behavior



Information capacity of neurons



SOURCE: K. PADMANABHAN & N. URBAN/NATURE NEUROSCIENCE 2010

In the animal

Tallying up the various classes, types and groups of neurons in the brain, and understanding how those neurons help encode extra information, is incredibly hard, says neuroscientist Chris Moore of Brown University in Providence, R.I. But the ultimate goal is even more difficult — figuring out how the diversity contributes to the behavior of a mouse sniffing around for food while avoiding a cat. “That’s a tall order,” Moore says.

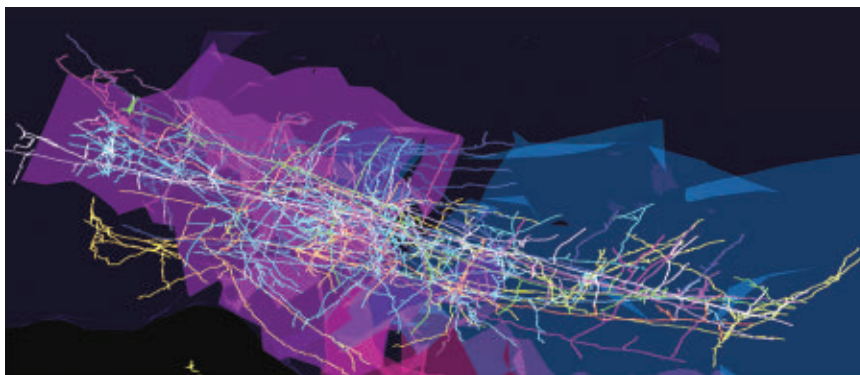
Last year, Moore and his colleagues wrote an essay in *Cell* (subtitle: “From diversity, strength”) exploring the various ways that diversity among brain cells might contribute to perception. The idea is that a diverse group of neurons could help the brain reliably recognize the same thing under a range of circumstances. “Whether it’s a bright sunny day, or a dark, cloudy day, you can still recognize your grandmother,” Moore says.

This ability to consistently recognize grandma in all sorts of lighting scenarios, or even in a grainy old photograph, might be a result of differences among neurons. Moore calls this “diversity for consistency’s sake.” Alternatively, neuron diversity might be behind the brain’s ability to flexibly assess different, unexpected things (or, as Moore puts it, “diversity for diversity’s sake”). Experiments are needed to sort out whether diversity helps in either — or neither, or both — of these scenarios.

Moore and his team are undertaking such experiments and turning up hints of potentially meaningful differences among the same interneurons that Yuste and McGarry study. A steady stream of information coming into the senses seems to spur some interneurons into action, while others couldn’t care less, preliminary studies from Moore’s lab show. Eventually, these disparate patterns of activity might help scientists decode perception, and more generally, mouse — or even human — behavior.

Understanding this variation might also have implications for neurological diseases. Diseases that cause neuron death, for instance, might selectively attack certain kinds of cells first. “What if some neurons are more sensitive to certain kinds of damage?” Urban says. “Is it a random subset, or is it something that’s a more insidious kind of damage?” Perhaps certain cells are extra-vulnerable to a stroke, or disease such as Alzheimer’s, or even normal aging.

If that’s true, then in addition to losing neurons, the brain would lose diversity, a deficit that could usher in even more damage. So far, this idea has some hints of support: In Urban’s simulations, a loss



Tracing mouse neuron extensions (colored lines) in the olfactory cortex has revealed that the shapes, locations and numbers of axon branches vary.

of diversity leads to “bizarre, pathological kinds of behavior” in networks of cells. And the loss of particular kinds of neurons has been tied to schizophrenia and Parkinson’s. A study published online June 8 in *Cerebral Cortex* shows that two specific kinds of neurons, fork cells and von Economo neurons, die early in people with a particular type of dementia. Researchers might be able to develop ways to protect the most vulnerable cells if they can figure out why some neurons succumb to certain diseases.

Diverse models of diversity

To uncover the hidden variety among such neurons, scientists would do well to take a suggestion from the neurons themselves, and diversify. The traditional way to capture neuron activity involves a single, finely tuned set of mathematical equations. These equations try to explain a cell’s behavior — the speed and strength of electrical signals, for instance — by averaging info from a group of cells. But a collection of models, each with its own strengths and weaknesses, may offer better results, says neuroscientist Eve Marder of Brandeis University in Waltham, Mass.

Single mathematical models are often geared toward catching the “Platonic ideal” of an individual neuron’s behavior, yet any biologist conducting experiments knows that no such thing exists, Marder writes online March 7 in the *Proceedings of the National Academy of Sciences*. Seeing fluctuations among neuron behavior in the lab, Marder says, “eventually led to

a whole different way of thinking about how to build models and how variable the underlying biology would have to be, or could be, or should be.”

Messy biological data call for diverse models. “If you assume that there’s a single output and a single solution, you may be missing really, really deep biological mechanisms,” she says.

These deep biological mechanisms, perhaps including diversity, might explain not only how the brain can operate so smoothly, but also how the brain came to be, too. Neurons with different sets of capabilities, looks and behavior invite natural selection in to sculpt the brain, nurturing cells that are helpful and pruning the ones that aren’t. Diversity may be the reason humans ended up with big brains in the first place. After all, as Marder points out, “Variability is a really great substrate for evolution to work on.”

Of course, it’s not like the brain had a choice, Marder says. The brain can’t make perfect neurons that roll off the assembly line with exact specifications. So for now, whether diversity among neurons is an inescapable bug that results from messy biology or a feature of a powerful, flexible brain may simply be irrelevant. The important thing is that this diversity exists, and appreciating it fully may bring scientists closer to understanding the mysterious brain in all of its wild glory. ■

Explore more

■ To view various neuron shapes, visit <http://bit.ly/mimOdY>

Rethinking what the first stars were like

By Ron Cowen

The Big Bang wasn't all it has been cracked up to be. Sure, it created the universe. But after the heat of the primordial fireball faded, the cosmos plunged into darkness. The universe was cold and black—a sea of hydrogen and helium atoms mixed with a mysterious dark form of matter making its presence known only by its gravity. No stars.

It took a series of violent events—starting about 100 million years after the Big Bang—to end the cosmic Dark Ages. First, the evenly spread dark matter gathered into clumps, pulling in hydrogen gas that coalesced into clouds. Then pressure inside the clouds grew strong enough to fuse atoms, triggering nuclear reactions. The first stars created this way

looked like roses with diaphanous petals, unfolding against a sea of darkness. The universe was finally in bloom.

The first stars marked a milestone in the history of the universe, bringing light and warmth back to the cosmos. Later, those primeval stars met their end in spectacular explosions known as supernovas, which seeded the universe with its first dollops of oxygen, carbon and silicon. Those elements made it possible for a second generation of stars to form.

The second-gen stars eventually burned through the opaque fog of hydrogen atoms and set the skies twinkling. These stars gathered into the first recognizable galaxies—dwarf galaxies of a few million stars. Dwarf galaxies merged, and after billions of years life emerged in one of the bigger galaxies, on a smallish backwater planet called Earth.

On that much, astronomers agree. But new simulations that track the star-formation process further than ever before are casting doubt on earlier

ideas about the properties of the first stars. They've been cast as loners and extremely massive, for instance. But now the massive-loner theory is in dispute. And that has profound consequences for nearly everything that happened next, because the mass of the first stars may have determined the size of the first galaxies and how quickly the second generation of stars could assemble to form them.

“There is widespread confusion and disagreement,” says astronomer Jason Tumlinson of the Space Telescope Science Institute in Baltimore. “I can no longer say with any confidence what the first stars were like.” But, he adds, “that’s what makes the field so exciting.”

New simulations, new ideas

Retracing the steps of star formation is a tricky business. Less than a decade ago, computer simulations by Tom Abel of Stanford's Kavli Institute for Particle Astrophysics and Cosmology and his

SIMULATION: MATTHEW TURK, BRIAN O'SHEA AND T. ABEL, IMAGE: RALF KAEHLER AND T. ABEL



LIGHTING
the universe

colleagues indicated that the first stars were whoppers — between 30 and 300 times as heavy as the sun — and that each formed in solitary confinement within separate clouds of gas (*SN: 6/8/02, p. 362*). The gas showed no sign of fragmenting into several stars; instead, it appeared that the condensing object would keep growing to become one behemoth. And because massive stars die out in just a few million years, none of these first stars could still exist in the universe today.

Although the researchers could follow the steps toward star formation during the first 100 million years or so of cosmic history, they could not track the additional 100,000 years it takes for an infant star to grow to its final size. The team had to stop because supercomputers couldn't — and still can't — precisely track the rapid changes in density a cloud core undergoes as it becomes a star.

Using a mathematical trick, however, other teams have now gone slightly

further, simulating about 1,000 years more of the star-formation process. Rather than attempting to track the rapid changes in the dense cloud core, these teams in effect ignore the core, treating it as a sink or black hole, with material falling onto the central region simply disappearing from sight.

Adopting that approach, the researchers have found evidence that a disk of material that forms around each of the embryonic stars can fragment into several fledgling stars, much the way the disk of material around the infant sun broke into clumps that formed the planets (*SN: 2/26/11, p. 18*).

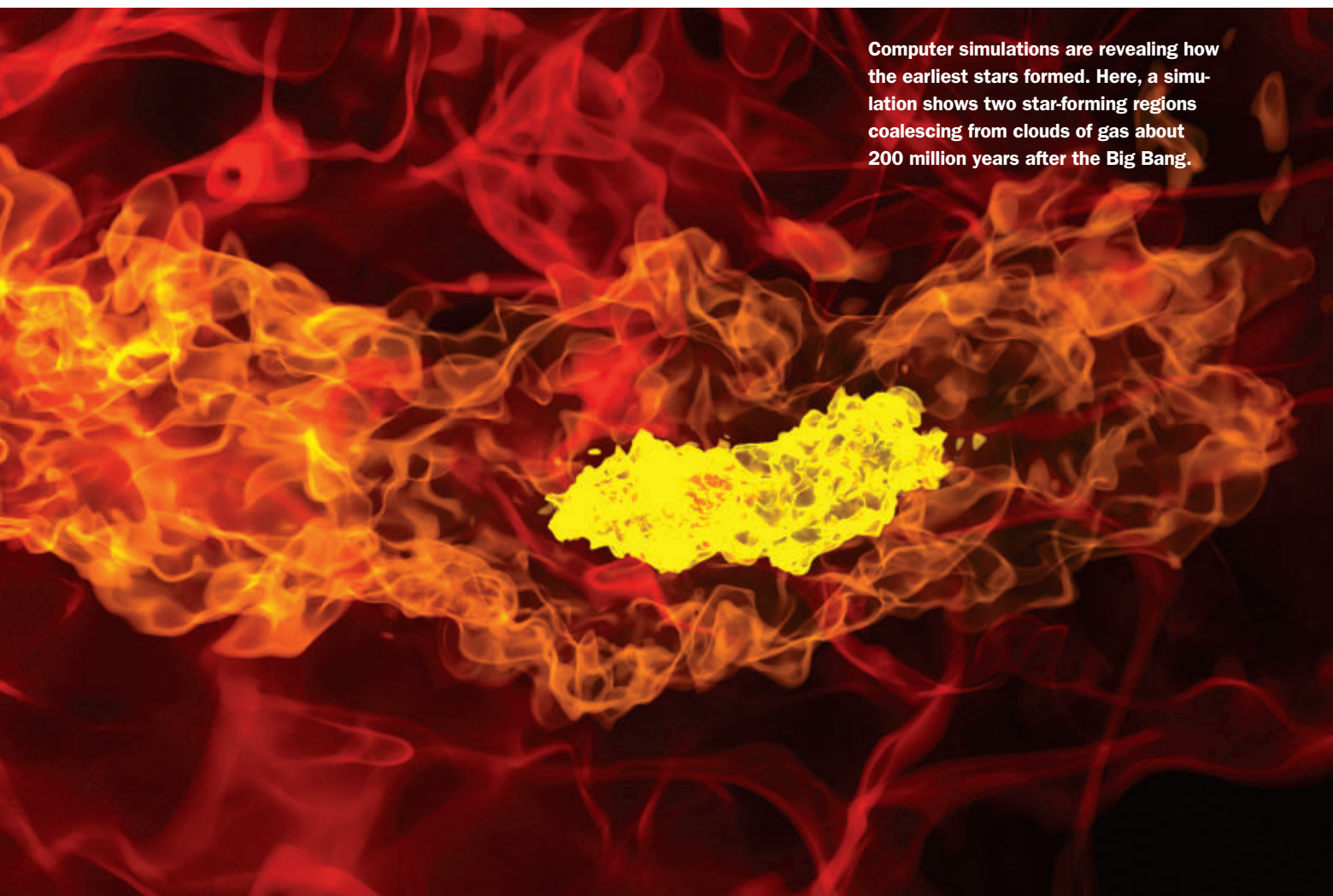
The net result, as these astrophysicists now see it, is that stars could have been born in pairs or even threesomes. Since they coalesce from the same cloud, each partner would be lighter than if it had formed in solitary confinement.

“Whether at the end of this process one, two or a few massive stars will remain is currently unknown,” says

Abel. Some studies even suggest that very small fragments, weighing no more than the mass of the sun, might form. Because low-mass stars take billions of years to burn out, some of the first stars could have survived to the present day, some researchers suggest.

To find out what the first stars were like, researchers are now looking to the scars those stars left behind — the extent to which they broke apart nearby atoms of hydrogen gas.

For instance, if most of the first stars were single and massive, they would have transformed the early universe into a giant hunk of Swiss cheese. That's because big stars emit copious amounts of ultraviolet light, which ionizes surrounding gases — stripping electrons from the neutral hydrogen and helium atoms that veiled the cosmos during the Dark Ages. The birth of each individual star would create an ionized bubble, or hole, in the gases around it. Over time, the universe would be riddled with these



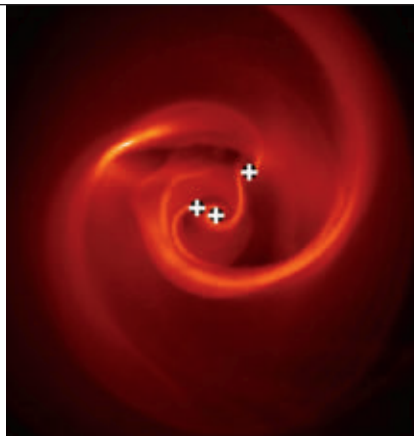
Computer simulations are revealing how the earliest stars formed. Here, a simulation shows two star-forming regions coalescing from clouds of gas about 200 million years after the Big Bang.

holes. Once the holes grew large enough to overlap, the universe would be almost completely ionized — as evidence suggests it has been ever since the cosmos was a few hundred million years old.

But if the very first stars were extremely massive, they could have prevented other stars from forming. The energy from their ultraviolet emissions would break molecules of hydrogen into atoms. Without hydrogen molecules, which provide a clump-promoting cooling effect, the dark matter at the heart of star formation would not have enough gravity to pull gas into a star.

If the new simulations showing that primeval stars were born with partners are correct, the universe might never have gone through a Swiss cheese phase, Zoltán Haiman of Columbia University thinks. If the partnerships were close enough, one star would be more likely to collapse to become a black hole and draw matter from the other, emitting X-rays in the process. Far more penetrating than ultraviolet light, the X-rays would rapidly strip electrons from hydrogen and helium atoms throughout the cosmos, leaving a uniformly ionized universe instead of holes, Haiman suggested in the April 7 *Nature*.

The stellar-partnership scenario



Recent simulations have shown that some of the first stars may have formed as twins or even triplets. Here, star embryos (crosses) form in a swirling cloud of hydrogen and helium gas.

could explain an enduring puzzle in the universe today, suggests a team led by I. Félix Mirabel of the French Atomic and Alternative Energies Commission in Gif-sur-Yvette, France and the Institute for Astronomy and Space Physics in Buenos Aires. The leading theory of dark matter predicts that the Milky Way should be surrounded by hundreds of dwarf galaxies, but observers have found only about 25. Mirabel’s team suggests in the April *Astronomy & Astrophysics* that the other dwarf galaxies exist but can’t

be seen because they’re starless — shadowy leftovers from the early universe, when such galaxies were too small to either forge or hold onto the first stars.

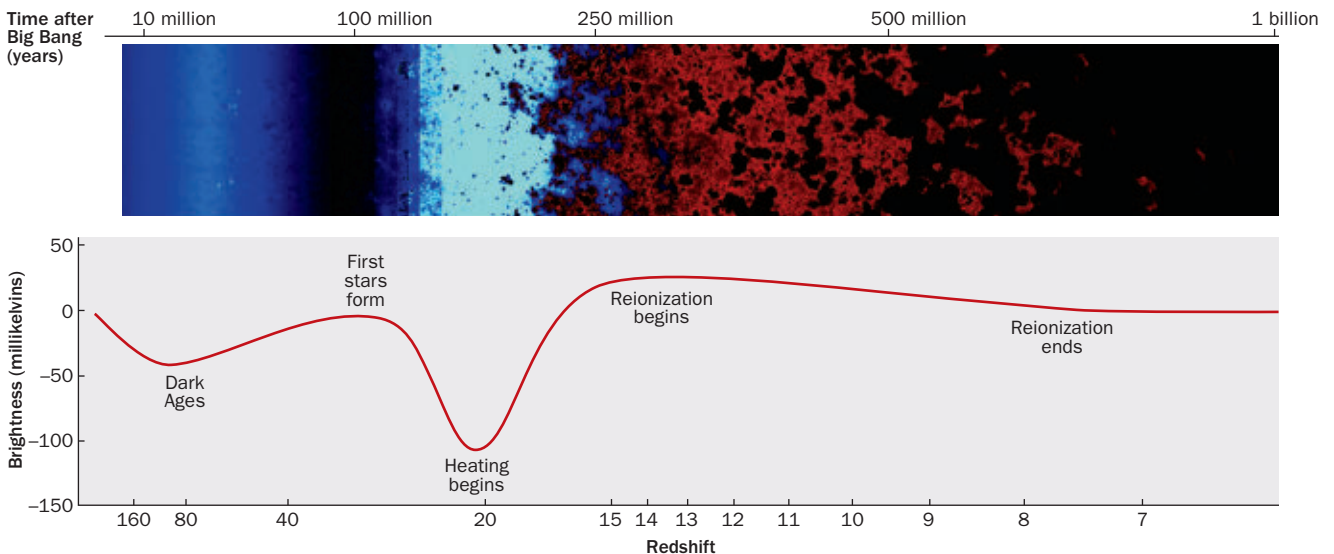
Researchers, however, don’t agree on how these X-ray-emitting partnerships would affect the universe. According to Haiman, the partners would emit so much more heat than a lone star that they would delay the formation of the first galaxies.

The extra heat from the stellar partners could boost the temperature and pressure of surrounding gases and prevent any clump of matter weighing less than a billion suns from corralling the gas to make new stars. Waiting around until dark matter clumps were that heavy may have delayed the onset of galaxy formation by 100,000 years.

But other astronomers disagree. Some theorists argue that rather than delaying the first galaxies, X-ray-emitting binaries would promote cooling that would hasten star formation. Tumlinson notes that through a chain of chemical reactions, X-rays would promote the formation of the HD molecule, in which one hydrogen atom is replaced by its heavier isotope, deuterium. That molecule might act as a new coolant.

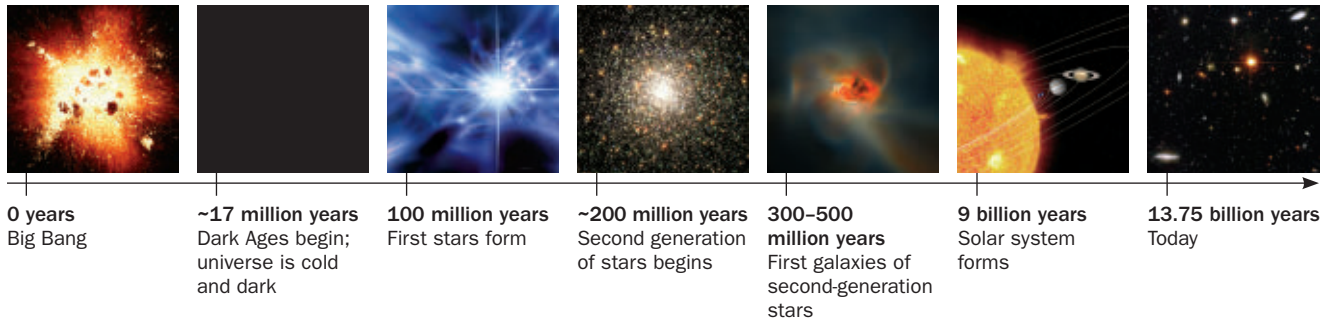
“People argue about this for hours at

Swiss cheese Researchers hope to reconstruct the star-formation process during the first billion years of cosmic history by measuring the brightness of 21-centimeter radio waves emitted by hydrogen relative to the cosmic microwave background (chart, bottom). Holes should appear (top, left to right) where radiation emitted by stars ionized hydrogen atoms, stripping electrons. As more stars formed, the holes would grow and merge, leaving the universe completely ionized as it is today. By seeing how quickly ionization proceeded, scientists hope to learn whether the first stars formed singly or in multiples.



FROM TOP: P. CLARK, S. GLOVER, R. SMITH, T. GREIF, R. KLESSEN, V. BROMM; TEXAS ADVANCED COMPUTING CENTER; J. PRITCHARD & A. LOEB/NATURE 2010

After the Bang The universe was a quiet place for millions of years after the Big Bang, plunged into darkness when electrons and protons cooled enough to combine into neutral hydrogen atoms. Today, scientists are reconstructing the series of events that led to the first stars, galaxies and ultimately the universe as seen today.



meetings and still there's no consensus," notes Tumlinson.

Ground truth

As the theorists continue to debate their models, observations to test their ideas are about to begin.

New arrays of radio telescopes will look for imprints that the first stars left behind on the clouds of hydrogen atoms surrounding them. Radio astronomers can tune in to radio waves from hydrogen atoms that existed at different epochs of the Dark Ages — before, during and after the first stars formed — thanks to shifts in wavelength caused by the expansion of the universe.

In particular, astronomers will look for radio emissions with wavelengths of 21 centimeters, which neutral hydrogen emits but ionized hydrogen cannot. If the Swiss cheese model is correct and the first stars were massive loners, observers should see the holes created when the stars broke apart the neutral hydrogen atoms.

By using 21-centimeter radiation to pinpoint if and when holes formed and merged, low-frequency radio telescopes such as LOFAR, a set of radio dishes spread across the Netherlands and other parts of Europe, will map out the history of the first stars, says Avi Loeb of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. Such maps should indicate whether the first stars were massive loners after all.

Last year in *Physical Review D*, Loeb and his Harvard-Smithsonian colleague

Jonathan Pritchard calculated that even a relatively inexpensive single radio dish that would record the intensity of the 21-centimeter radio emission averaged over the entire sky could indicate when the first stars were born and how quickly they ionized helium and hydrogen atoms by emitting ultraviolet light or X-rays.

Other researchers are attempting to read a fossil record of the elements cast into space by the very first generation of stars. Theorist John Wise of Princeton University and his colleagues are trying to simulate the second generation of stars, dubbed Pop II, which are the first stars that got incorporated into galaxies. Because Pop II stars are small enough to be relatively long-lived, researchers can examine them to see what they inherited from their parents' generation.

"Astronomers are actually able to see Pop II stars in galaxies" and learn about their predecessors, says Wise. In addition to giant, 30-meter ground-based telescopes that astronomers are now planning to build, the James Webb Space Telescope, which researchers hope will launch late this decade, will closely examine Pop II stars from the first galaxies.

But researchers aren't just waiting for Webb to be launched. Astronomers using the European Southern Observatory's Very Large Telescope in Chile are getting a head start by re-examining the surfaces of eight elderly Milky Way stars. The stars are at least 12 billion years old and are probably members of the Pop II generation, Cristina Chiappini of the Leibniz Institute for Astrophysics

Potsdam in Germany and her colleagues report in the April 28 *Nature*.

The team found high abundances of two rare, heavy elements — strontium and yttrium — relative to iron. To explain the composition of those second-generation stars, the researchers propose that the first stars were massive and rotated rapidly, spinning about 250 times faster than the sun. By mixing different layers of nuclear-burning gases, these whirling dervishes could trigger a chain of nuclear reactions that could have produced the high levels of strontium and yttrium.

If the first stars were fast rotators, they would be more likely to end their lives as gamma-ray bursts, Tumlinson notes in a commentary accompanying the *Nature* article. Such bursts are the most powerful explosions in the universe and would serve as cosmic fireworks that would brilliantly signal the first stars' demise.

The bursts would be the ultimate messengers — death throes that traveled billions of light-years through space to reach Earth. For Loeb, recording those signals would be the thrill of a lifetime. "This is our roots, our origins," he says. The bursts would put humans face to face "with our earliest ancestors, one star at a time." ■

Ron Cowen is a freelance science writer in Maryland.

Explore more

■ See simulations of the first stars by Tom Abel and colleagues: www.slac.stanford.edu/~tabel/GB/index.html

The Science of Evil

Simon Baron-Cohen

The depths of human cruelty are often summed up in one stark term: evil. But definitions of evil are frustratingly circular, since evil is as evil does. “For a scientist this is, of course, wholly inadequate,” writes Baron-Cohen, a developmental psychologist specializing in autism. He suggests that “evil” is more properly defined as a complete lack of empathy, the ability to imagine and respond emotionally to another person’s thoughts. Empathy, he argues, is distributed throughout the population as a bell curve, with those at the low end of the curve populating psychiatric categories such as psychopathy, narcissism and borderline personality disorder.

The book argues that the roots of the empathy bell curve lie in the brain and are shaped both by genes and by environmental factors such as parental neglect and abuse. Chapters lay out differences in brain structure and function found among people along the empathy

spectrum, based on Baron-Cohen’s and others’ research. Many questions remain about the physical basis of behavior, but the core idea that physiology can affect empathy is supported by an emerging body of research. And the author’s own work on autism, marked by difficulties relating to the minds of others, offers excellent examples of brain differences in action.

More provocative is Baron-Cohen’s assertion that low empathy can in some cases be associated with positive traits, such as the strictly moral behavior of some people with Asperger’s syndrome. Whether this is a “positive” outcome is not a scientific call but a value judgment, and Baron-Cohen is more persuasive when he sticks to describing the cutting edge of neuroscience. — *Erika Engelhaupt*
Basic Books, 2011, 240 p., \$25.99



Periodic Tales

Hugh Aldersey-Williams

Before phosphorus became a common ingredient in lightbulbs and bombs, early chemists isolated it from urine — at the time, an at-hand source of undiscovered chemicals. According to a recipe by English scientist Robert Hooke, it was best to start with 50 to 60 pails of the stuff.

Buckets of pee probably aren’t the first thing most people think of when they eye the periodic table, but such images seem to pop readily into Aldersey-Williams’ mind. This scientist-turned-writer dives into the discovery of many of the table’s now famous letters — P, S and O — and even some of the more obscure — Eu, Er and Yb. But he’s also interested in the cultural cachet of those elements. Phosphorus, for instance, went from a glowing,

albeit stinky, symbol of scientific ingenuity to an ingredient in white-hot bombs, capable of burning entire cities.

Like the periodic table itself, the book is episodic. But that’s not always a bad thing. Many of the elements highlighted come with strong narratives (see the chapter on chromium for the story of an element that rose and fell in the public eye over the span of a few decades).

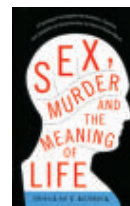
Chemistry buffs should be warned, however, that this sometimes personal endeavor is about as far away from a textbook as hydrogen is from radon on the iconic table. Aldersey-Williams doesn’t spend much time explaining why neon is inert, but he does explore the element’s associations with American flashiness. In other words, this is the book for those who spent science class wishing they were reading Nabokov instead. Or, perhaps, for chemistry buffs willing to take their valence electrons with a touch of whimsy. — *Daniel Strain*
Ecco, 2011, 428 p., \$29.99



The Stem Cell Hope

Alice Park

A narrative account explores the history of stem cells through the stories of scientists and patients. *Hudson Street Press, 2011, 318 p., \$25.95*



Sex, Murder and the Meaning of Life

Douglas T. Kenrick

Anecdotes enliven a psychologist’s take on the role of evolution in murderous fantasies, racial prejudice and other unsavory aspects of human nature. *Basic Books, 2011, 238 p., \$26.99*



Saving Sea Turtles

James R. Spotila

A turtle biologist makes a plea to save sea turtles, remarkable creatures that start life buried in up

to two feet of sand. *Johns Hopkins Univ. Press, 2011, 216 p., \$24.95*



The Power of Music

Elena Mannes

A music lover interviews scientists and musicians in this fun exploration of the science of music. *Walker & Company, 2011, 263 p., \$26*



The Quest for the Cure

Brent R. Stockwell

In this well-researched look into the complexities of making medicines, a chemical biologist gives a history of drug making and details innovative methods of drug discovery. *Columbia Univ. Press, 2011, 265 p., \$27.95*

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Irrational with money

Bruce Bower's excellent article on "Simple heresy" (SN: 6/4/11, p. 26) showcases the blindness of mainstream economics. Namely, economics is often more like the weather than a game of dice: chaotic — with catastrophes, cycles and all manner of weird behavior. Yet economists continue to use statistical models that work "until they don't." So it is not surprising that investment strategies that use simple heuristics may do better than the pseudoscience of economists. Meanwhile, real science is not stymied by chaos, as climate science is now demonstrating.

Dick Burkhardt, Seattle, Wash.

I have thought for years that economists and their ilk must live in some parallel universe where all decisions made by consumers are rational and well-thought-out, with reams of diligent research to back every choice. In my experience most people make

decisions based on three simple rules. First, my coworker/neighbor/best friend has it and they love it. Second, it's what I've always used and I see no reason to change. Third, it was on sale.

Michael Ellison, Clayton, N.C.

Social influence, minus the ads

Regarding Rachel Ehrenberg's "A few master switches can rule a network" (SN: 6/4/11, p. 5): Cute article, but everyone seems to have missed the big point on online social networks. Most material posted on these sites is not read by anyone but the poster.

Go ahead, shove an ad onto Facebook at the 20 percent most effective nodes and it will be ignored by 99 percent of the recipients.

Flo Muller-Reed, via e-mail

Thanks from a new reader

I am new to *Science News* magazine. I discovered your publication by accident. It has been an enjoyable

experience to read its contents at each arrival. I sincerely have found a far better understanding of "Science" and "science" [see "Textbook science defers to supremacy of Science," SN: 6/4/11, p. 2]. Please continue your good work helping the layperson to understand his world.

Newton Quinn, via e-mail

Clarification

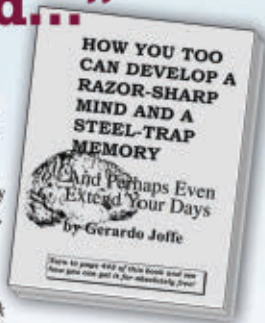
The rough representation of the intersection of the Red Sea and Gulf of Aden rifts in the map on Page 23 of "Death of a continent, birth of an ocean" (SN: 7/2/11, p. 22) is not as precise as current scientific maps of the rift. A wealth of literature suggests that the rifts avoid the strait between Arabia and Africa and instead meet in the Afar region.

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Sid Tuchman of Indianapolis, IN says: "What an astonishing book! One can almost hear those brain cells crackle!" And Lloyd Hammett of Winfield, LA adds: "If this book will not make you smarter, nothing will." And Hugh Cunningham of Albany, GA says: "This is marvelous! I already feel a whole lot smarter than before I started on this book!"

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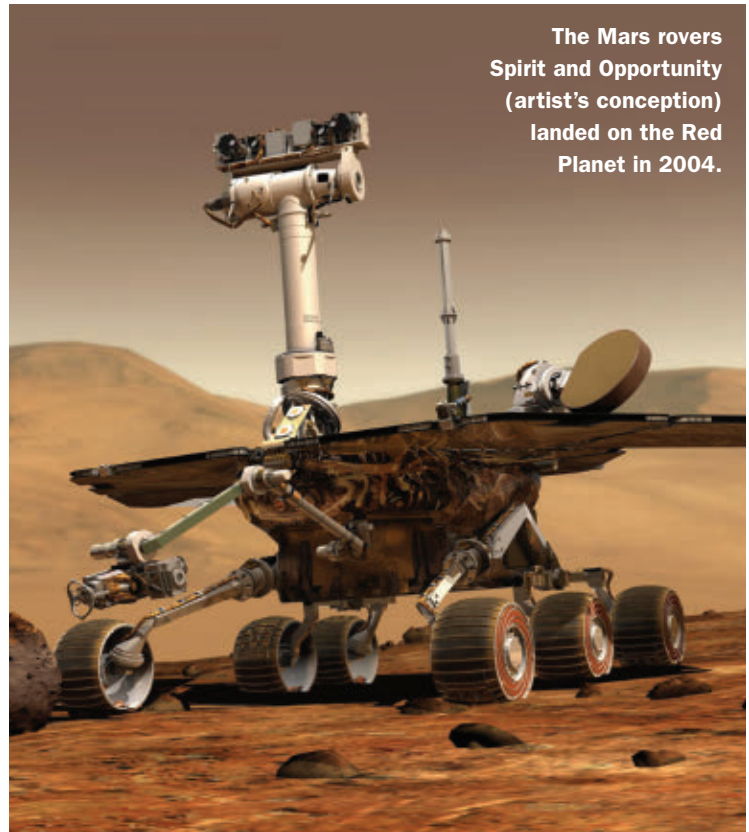
To read the full 1960 article, visit www.sciencenews.org/archive_mars60

Men to Mars Possible in 60's, Experts Say

THE UNITED STATES will be able to send three men on a 14-month expedition to Mars in a nuclear-powered two-stage rocket ship during the 1960's, three space experts assert.

The rocket ship would go into orbit around Mars, and the exploring party would use a chemically propelled "taxi" to go down for a close look at the Martian landscape. After exploring for two months, the party would refuel their orbiting space ship and head back to earth.

Tanks of hydrogen, for refueling purposes, would be launched about a month earlier than the manned ship to make certain they are on course and that the hydrogen will be available on Mars. These tanks, taking a slower, easier path, would arrive at Mars after the manned ship. Three tankers each carrying 88,000 pounds of propellant could provide enough fuel for the return flight.



The Mars rovers Spirit and Opportunity (artist's conception) landed on the Red Planet in 2004.

UPDATE

Kennedy was a moon guy, Obama prefers Mars

Like chocolate or vanilla, white or wheat, boxers or briefs, the choice between sending astronauts to explore the landscape of the moon versus that of Mars has joined the list of life's deepest debates.

Though at first the notion that people could have walked on the Red Planet by the end of the 1960s seems silly, when the historical context is considered, it's not so hard to imagine how a manned mission to Mars seemed attainable.

Enthusiasm about space during the '50s may be second only to the excitement of the '60s. Improvements in rocket technology made it possible to send more weight farther. And Sputnik got Americans thinking about how they could claim their place in space.

When NASA was established in 1958, lunar and planetary exploration were on the top of the agenda. But the moon took the lead when President John F. Kennedy in 1961 famously said, "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to

the Earth." Though the planets were on the minds of many, political priorities were clear.

Since then, a number of people proxies have landed on Mars: Viking 1 and 2, Pathfinder, Spirit, Opportunity, Phoenix. But the boots of an astronaut have not yet touched down. Beyond the additional technologies required for a manned mission, scientists have to consider the physical and psychological effects of a year-plus trip.

But Mars may finally get its turn. Last year President Obama announced that the United States would abandon plans for another visit to the moon and instead focus on Mars. Such a mission is not expected to launch for at least another 20 years. — *Elizabeth Quill*

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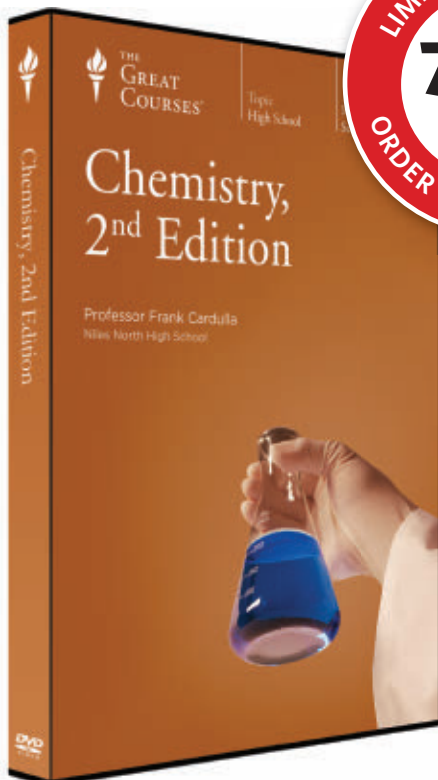
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