Remapping the Galaxy | Thought-Controlled Robotics | Brown Fat Burns

www.sciencenews.org

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ JUNE 16, 2012

Under pressure

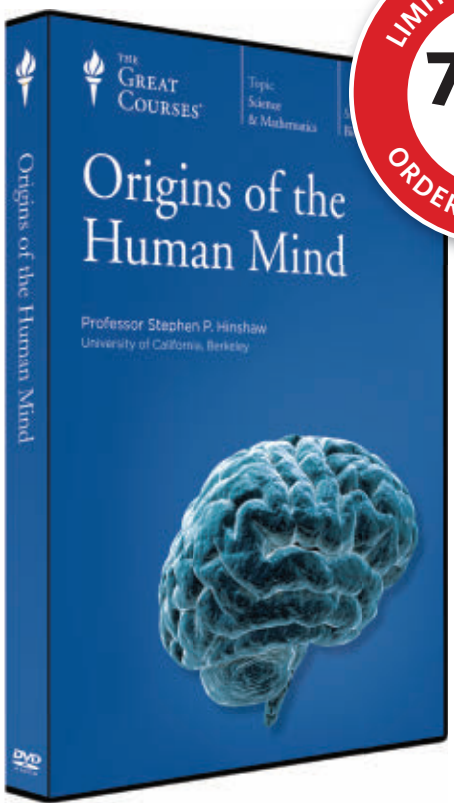
How deep-sea critters survive the ocean's crushing weight

Sun's Missing Shock Wave

Happy Seniors, Bad Choices

Good Cholesterol May Be Just OK

THE GREAT COURSES®



What are the Origins of the Human Mind?

For thousands of years, the human mind has been shrouded in mystery. Yet with the latest advancements in our understanding of the brain and the technology we use to look inside it, scientists have discovered answers to questions that have long perplexed humanity. **Origins of the Human Mind** is your guide to what today's neurobiologists, psychologists, and other scientists know about the workings of the mind: one of the hottest subjects in modern science.

Award-winning Professor Stephen P. Hinshaw—whose training as a psychologist straddles the science of the mind and its impact on individuals—approaches the development of the mind from both the evolutionary scale and the scale of an individual lifespan. Along the way, he explores provocative issues such as the nature-versus-nurture debate; the development of mental illness; and the roots of emotional bonds and brain plasticity.

Offer expires 08/15/12

1-800-832-2412

WWW.THEGREATCOURSES.COM/4SN

Origins of the Human Mind

Taught by Professor Stephen P. Hinshaw
UNIVERSITY OF CALIFORNIA, BERKELEY

LECTURE TITLES

1. Brains and Minds, Evolution and Development
2. How the Human Brain Works
3. Development of the Human Brain
4. Evolution and the Brain
5. Psychological Views of the Mind
6. Instinct, Learning, and Emotion
7. Microevolution, Culture, and the Brain
8. Infancy—Temperament and Attachment
9. Childhood—Stages and Widening Contexts
10. Adolescence—Rebellion, Identity, and Self
11. Adulthood—Aging, Horizons, and Wisdom
12. Influences of Sex and Gender
13. Parallels between Development and Evolution
14. Myths and Realities of Heritability
15. Genes and Environments Together
16. The Abnormal Mind—What Goes Wrong?
17. Rationality, Psychosis, and Schizophrenia
18. Emotion Regulation and Mood Disorders
19. Attention, Impulse Control, and ADHD
20. Empathy, Social Connections, and Autism
21. Evolution and the Paradox of Mental Illness
22. Roots of Religion, Aggression, and Prejudice
23. Bringing in Personal Narratives
24. The Future of the Human Mind?

Origins of the Human Mind
Course no. 1663 | 24 lectures (30 minutes/lecture)

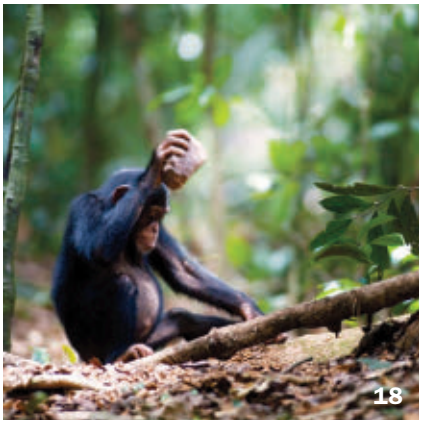
SAVE UP TO $185

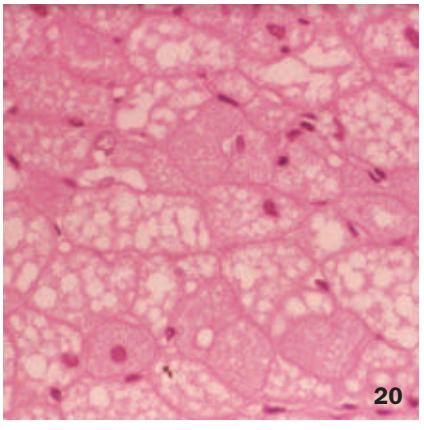
DVD ~~$254.95~~ NOW $69.95
CD ~~$179.95~~ NOW $49.95

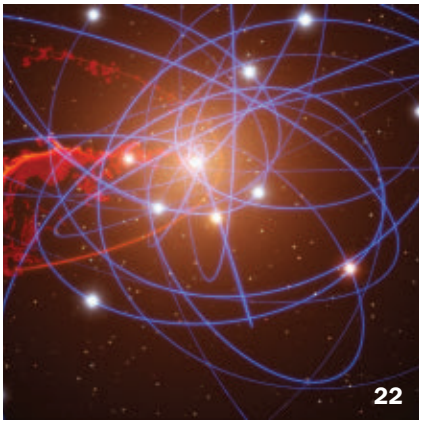
+$10 Shipping, Processing, and Lifetime Satisfaction Guarantee
Priority Code: 65462

Designed to meet the demand for lifelong learning, The Great Courses is a highly popular series of audio and video lectures led by top professors and experts. Each of our more than 350 courses is an intellectually engaging experience that will change how you think about the world. Since 1990, over 10 million courses have been sold.

JUNE 16, 2012 • VOL. 181 • NO. 12







ScienceNews

In The News

Features

Departments

COVER This deep-sea glass squid thrives in the ocean depths off New Zealand. New work probes how life has adapted to such high-pressure environments. © *Peter Batson, DeepSeaPhotography.Com*

ScienceNews
MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

PUBLISHER Elizabeth Marincola
EDITOR IN CHIEF Tom Siegfried

EDITORIAL
MANAGING EDITOR Eva Emerson
SENIOR EDITOR/POLICY Janet Raloff
DEPUTY MANAGING EDITOR, NEWS Matt Crenson
DEPUTY MANAGING EDITOR, FEATURES Elizabeth Quill
DEPARTMENTS EDITOR Erika Engelhaupt
ASSOCIATE EDITOR Kate Travis
CONTRIBUTING EDITOR Alexandra Witze
ASTRONOMY Nadia Drake
BEHAVIORAL SCIENCES Bruce Bower
BIOMEDICINE Nathan Seppa
CHEMISTRY/INTERDISCIPLINARY SCIENCES Rachel Ehrenberg
LIFE SCIENCES Susan Milius
MOLECULAR BIOLOGY Tina Hesman Saey
NEUROSCIENCE Laura Sanders
STAFF WRITER Devin Powell
EDITORIAL ASSISTANT Allison Bohac
WEB SPECIALIST/EDITORIAL SECRETARY Gwendolyn K.N. Gillespie
SCIENCE WRITER INTERN Rebecca Cheung
CONTRIBUTING CORRESPONDENTS Laura Beil, Susan Gaidos, Charles Petit

DESIGN
DESIGN DIRECTOR Beth Rakouskas
ASSISTANT ART DIRECTORS Theresa Dubé, Erin Feliciano

ADVERTISING | CIRCULATION
CIRCULATION MANAGER Tosh Arimura
ADVERTISING Jonathan Sismey, *Eastern Director*; Mike Walker, *Western Director*
ADVERTISING/CIRCULATION ASSOCIATE Kerwin Wilson
PERMISSIONS Evora Swoopes

SOCIETY FOR SCIENCE & THE PUBLIC

BOARD OF TRUSTEES **CHAIRMAN** H. Robert Horvitz
VICE CHAIR Jennifer Yruegas **SECRETARY** Gayle Wilson
TREASURER Robert W. Shaw Jr. **MEMBERS** Craig R. Barrett, Michela English, S. James Gates Jr., Tom Leighton, Alan Leshner, Stephanie Pace Marshall, Patrick McGovern, Joe Palca, Frank Wilczek; Elizabeth Marincola, *ex officio*

EXECUTIVE OFFICE **PRESIDENT** Elizabeth Marincola
EXECUTIVE ASSISTANT Amy Méndez

FINANCE **CHIEF FINANCIAL OFFICER** Greg Mitchell
ACCOUNTING MANAGER Lisa M. Proctor **SENIOR ACCOUNTANT** Sivakami Kumaran

EXTERNAL AFFAIRS **CHIEF ADVANCEMENT OFFICER** Rick Bates
SENIOR DEVELOPMENT MANAGER Stephanie Heishman
SENIOR COMMUNICATIONS MANAGER Sarah Wood
SOCIAL MEDIA Patrick Thornton **EXTERNAL AFFAIRS** Nancy Moulding
DEVELOPMENT COORDINATOR Charles Heidlage

EVENTS MANAGEMENT **DIRECTOR** Cait Goldberg **ASSOCIATE** Marisa Gaggi

SCIENCE EDUCATION PROGRAMS **DIRECTOR** Michele Glidden
INTEL SCIENCE TALENT SEARCH MANAGER Caitlin Sullivan
BROADCOM MASTERS MANAGER Stephanie Lemnios
INTERNATIONAL FAIRS MANAGER Sharon Snyder
DOMESTIC FAIRS Laurie Demsey **VOLUNTEERS AND SPECIAL AWARDS** Diane Rashid
AWARD AND EDUCATION PROGRAM ADMINISTRATION June Kee
INTERNATIONAL FAIRS SPECIALIST Jinny Kim **PROGRAMS ASSOCIATE** Laura Buitrago
ALUMNI AND TEACHER COORDINATOR Allison Hewlett

INTERNAL OPERATIONS **DIRECTOR** Harry Rothmann
NETWORK MANAGER James C. Moore
OPERATIONS MANAGER Anthony Payne **FACILITIES** Paul Roger
INFORMATION TECHNOLOGY PROJECT MANAGER Vikram Chiruvolu
INFORMATION TECHNOLOGY Thomas D. Smith, Gregory A. Sprouse
BLACKBAUD ENTERPRISE ADMINISTRATOR Alan Gordon **MAILROOM** Randy Williams

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
1719 N Street NW, Washington, DC 20036 **Phone** (202) 785-2255
Audit Bureau of Circulations
Subscriptions subs@sciencenews.org **Editorial/Letters** editors@sciencenews.org
Advertising/Business snsales@sciencenews.org
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 © 2012 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

Astronomers pin down Earth's place in universe

Understanding humankind's place in the cosmos has long been a preoccupation of the deepest human thinkers. From the ancient Greeks, to Copernicus, to Einstein and Hubble, the greatest skywatchers have shared three concerns in common with real estate agents: location, location, location.

Back in Aristotle's day (and he was no dope), conventional wisdom (i.e., his) placed the Earth at the center of the universe. It seemed obvious enough that all those celestial spheres carrying planets and stars in circles around the sky had to be circling the Earth. Aristarchus of Samos knew better, but Aristotle had better publicity.

Almost two millennia later, Copernicus revived Aristarchus' idea that the Earth revolved around the sun, while the sun retained center-of-the-universe status. But of course, it turned out that the sun was just one of many billions of stars in the Milky Way galaxy. And by the end of the 19th century it seemed that the sun was just somewhere near the middle of the Milky Way, not dead center.

A century ago, astronomers began to realize that the Milky Way was not the whole universe, and the Earth (and sun) never passed anywhere even close to the Milky Way's core. (Good thing, as the gigantic black hole there would not have been a pleasant neighbor.) Planet Earth's address turns out to be in a rather rural region of the Milky Way, as contributing editor Alexandra Witze notes in this issue (Page 22).

From this remote vantage point, Earth's scientists have been mapping the galactic continent more and more precisely, turning up such surprises as the existence of previously unseen spiral arms. New details are emerging about the structure of the galactic bulge surrounding the black hole core. Better estimates have been inferred about the galaxy's mass.

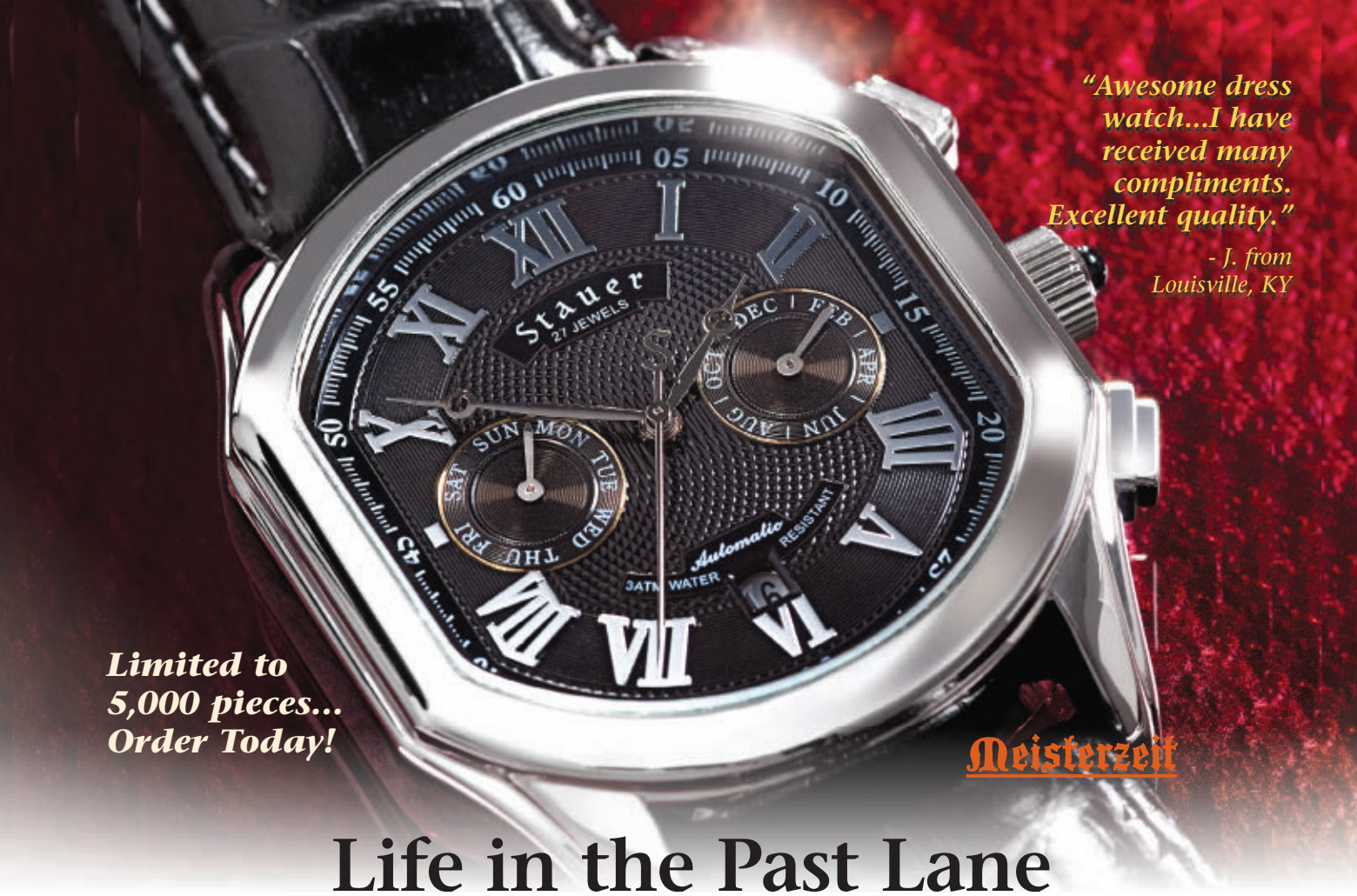
All these insights into the Earth's cosmic neighborhood better inform astronomers about the history of the galaxy and aspects of its future (along with implications for the workings of all those sister galaxies careening through spacetime). Observations of the Earth's galactic environs consequently illuminate not just Earth's place in the cosmos, but the nature of the whole cosmos itself.

In any event, no matter which coordinates of cosmic geography it happens to occupy, there's no place like home.

—Tom Siegfried, Editor in Chief

Society for Science & the Public is a 501(c)3 nonprofit corporation founded in 1921. The vision of Society for Science & the Public is to promote the understanding and appreciation of science and the vital role it plays in human advancement: to inform, educate, inspire. Visit Society for Science & the Public at **www.societyforscience.org**. Republication of any portion of *Science News* without written permission of the publisher is prohibited. For permission to photocopy articles, contact Copyright Clearance Center at 978-750-8400 (phone) or 978-750-4470 (fax). Advertising appearing in this publication does not constitute endorsement of its content by *Science News* or Society for Science & the Public.

JIM WEBB



Life in the Past Lane

A watch legend comes back in black! Wear the Midnight Meisterzeit for ONLY $99!

Turn down the lights. Raise the curtain. Your wait is over. After 89 years, this classic is back on stage. And it's clear that the old black magic is as powerful as ever. This is what happens when "fashionably late" meets "right on time." Inspired by one of the world's first automatic wristwatches, we have painstakingly crafted the ***Stauer Midnight Meisterzeit*** to meet the demanding standards of vintage watch collectors. And for a limited time it's yours for under $100!

Your new watch is history. That legendary original was a rare prototype, hand-built by a master of the mechanical arts. The idea that we could recreate it seemed as far-fetched as repainting Picasso. Until we realized it was possible to make our version even better. Its startling good looks get all the attention, but this watch is more than just tall, dark and handsome.

Why our "new antique" is better than the original. We found a way to engineer the ***Midnight Meisterzeit*** with a much higher level of precision. The 27-ruby-jewel movement utilizes an automatic self-winding mechanism inspired by the 1923 patent, but built on $31 million in state-of-the-art Swiss machinery. Imagine putting a 21st-century performance engine into the body of a 1920s roadster. The ***Midnight Meisterzeit*** is powered entirely by the movement of your body. It never needs batteries and never needs to be wound. It secures with a genuine black leather strap and is water-resistant to 3 ATMs.

The balance wheel and escapement can be seen under the Cotswold™ crystal and exhibition back.

Your satisfaction is 100% guaranteed. Order the ***Stauer Midnight Meisterzeit*** and claim a piece of watchmaking history in a rare design priced to wear everyday. If you're not captivated with the ***Midnight Meisterzeit***, simply return it within 30 days for a full refund of your purchase price. But we're convinced that once you experience life after ***Midnight***, you'll find there's no reason to be afraid of the dark!

WATCH SPECS: - 27-jeweled Vertex automatic movement - Exhibition back - Genuine black leather band fits wrists 7 1/4"–8 1/8"

Another Stauer Exclusive Not In Stores

Stauer Midnight Meisterzeit Timepiece—~~$395~~

Now $99 +S&P

Call now to take advantage of this extremely limited offer.

1-800-721-0297

Promotional Code MMW160-01
Please mention this code when you call.

ACCREDITED BUSINESS **Stauer has a Better Business Bureau Rating of A+**

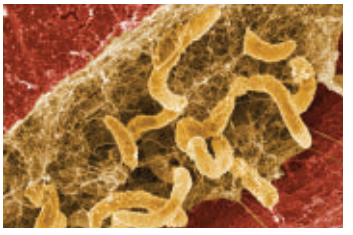
Stauer®

14101 Southcross Drive W., Dept. MMW160-01
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices

ADVERTISEMENT

Say What?



Biofilm *BI-oh-film*\ **n.** A community of one or more bacteria species held together by a sticky, mucuslike substance. Dental plaque may be the most familiar example, but biofilms also play a role in some chronic infections, especially those that occur around medical devices like pacemakers and catheters. In the April 27 *Cell*, a team of Harvard researchers announced that an organic compound called norspermidine, found in the biofilm of a soil bacterium, works with certain amino acids to break up the gluey matrix that holds the bacterial clusters together. Norspermidine also stopped biofilms from forming in two other bacterial species: *Escherichia coli* and the staph infection–causing *Staphylococcus aureus*. —*Allison Bohac*

Science Past | FROM THE ISSUE OF JUNE 16, 1962

COMPUTER CALCULATES B.C. POSITIONS OF PLANETS — The positions of the planets, the moon and the sun from 601 B.C. to 1 A.D. have been calculated using an electronic "brain," or computer. The astronomical tables are expected to provide scholars with new insight in the study of ancient civilizations.... Dr. O. Neugebauer of Brown University, Providence, R.I., has worked with astronomical predictions from the pre-Christian era. Even before publication, the tables were used in dating and piecing together fragments of Babylonian clay tablets containing ancient astronomical records. The analysis and computer programs for constructing the planetary, lunar and solar positions were based on modern mathematical theories describing the motions of the planets, together with improvements based on ancient observations.

Science Future

June 25–29
Check out summer camps on space, flight and more at the Center of Science and Industry in Columbus, Ohio. More dates listed at bit.ly/SFcosicamp

June 25–August 13
Headfirst's Imagination Science camps in the D.C. area cover rockets, crime scenes and robots. See bit.ly/SFdcscicamp

July 2–6
"The Zoo and You" camp at Santa Ana Zoo in California teaches 5- to 6-year-olds all about animals. Other dates available. See bit.ly/SFzoocamp

SN Online

www.sciencenews.org

BODY & BRAIN
A new strategy boosts insulin production in mice. Read "Procedure offers hope in type 1 diabetes."

SCIENCE & SOCIETY
A 17-year-old shows off his homemade nuclear fusion reactor (below) at the Intel International Science and Engineering Fair. See "At ISEF, fusion is hot."

MATTER & ENERGY
The Leidenfrost effect allows physicists to control liquid oxygen's movement. See "Dancing droplets reveal physics at work."

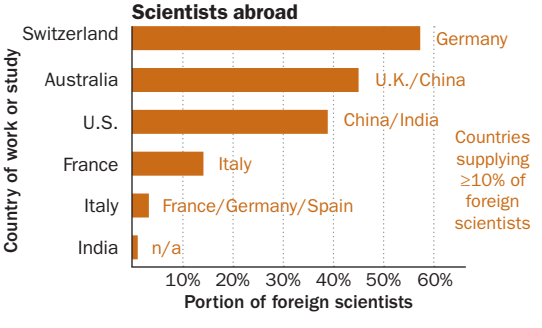
GENES & CELLS
Scientists use DNA signatures to predict disease in "Schizophrenia's core genetic features proposed."

How Bizarre | TOWARD BIONIC SNAILS

Snails and their sluggish brethren typically don't invoke thoughts of energy, but the creatures may soon power tiny devices. U.S. and Israeli researchers have created a fuel cell that runs on the glucose and oxygen in a snail's bloodlike hemolymph. When implanted in the land snail *Neohelix albolabris* (shown), the fuel cell eked out electricity over several months with no harm to the snail, researchers report in the March 21 *Journal of the American Chemical Society*. The power is less than an AAA battery can provide, but eventually such snails — and other creepy crawlies such as cockroaches — might be rigged with fuel cell–powered sensors and wireless transmitters for environmental monitoring or even spycraft. — *Rachel Ehrenberg*

Science Stats | SCIENTISTS ON THE MOVE

A survey of scientists working outside their home countries finds that Switzerland hosts the largest fraction of immigrant scientists, with more than half the nation's scientists having had residence elsewhere at age 18. India has the smallest fraction (0.8%).



SOURCE: C. FRANZONI *ET AL*/NAT'L BUREAU ECON. RES. 2012

CLOCKWISE FROM TOP: ENVIRONMENTAL MOLECULAR SCIENCES LABORATORY; DEVIN POWELL; AMERICAN CHEMICAL SOCIETY

“I’m right-handed, so it’s very comfortable and feels natural to imagine my right hand moving in the direction I want the robotic arm to move.” —CATHY, PAGE 6

In the News

STORY ONE

For coffee break, woman guides robotic arm with her thoughts

Brain-computer link could enable control of prosthetics

By Rachel Ehrenberg

Directing a robotic arm with her thoughts, a paralyzed woman named Cathy can pick up a bottle of coffee and sip it through a straw, a simple task that she hasn’t done on her own for nearly 15 years. The technology that brought about the feat is a brain-computer interface system: A computer decodes signals from a tiny chip implanted in Cathy’s brain, translating her thoughts into actions that are carried out by the robot arm.

The seemingly mundane task of bringing a drink to one’s mouth is the first published demonstration that severely paralyzed people can conduct directed movements in three-dimensional space using a brain-controlled robotic device. This latest application of the system, called BrainGate, is described in the May 17 *Nature*.

“Much has been demonstrated in terms of laboratory work and monkeys, but this is the first time showing something that’s going to be useful for patients,” says neuroscientist Andrew Jackson of Newcastle University in England. A commentary by Jackson on the new developments appears in the same issue of *Nature*.

There’s still a lot of work to do before BrainGate can be used outside a lab. In the current design, the tiny sensor that sits in the patient’s brain is attached to a mini fridge–sized computer via ungainly wires. So making the system wireless is one goal.

The researchers hope that within a decade the BrainGate system will be available and affordable for people who are paralyzed or have prosthetic limbs. Eventually, similar technology might restore function to a natural limb that no longer works.

“In many ways the real dream of the research is one day to connect brain to limb.” LEIGH HOCHBERG

“In many ways the real dream of the research is one day to connect brain to limb,” says neurologist Leigh Hochberg of Brown University in Providence, R.I., Massachusetts General Hospital and the Department of Veterans Affairs. He is leading the BrainGate trials.

In BrainGate’s current arrangement, a baby aspirin–sized silicon sensor is implanted in the patient’s motor cortex. In this part of the brain, neurons are laid out in a map that corresponds to parts of the body. The sensor, which contains 96 electrodes, is implanted a few millimeters deep in the motor cortex’s “arm” area. Thin wires lead from the sensor to a penny-sized pedestal beneath the skin that connects to a plug atop the head. Wiring from the plug goes to a computer. When Cathy thinks about moving her paralyzed arm, elaborate algorithms decode the signals picked up by the electrodes and translate them into commands that are carried out by the robotic arm.

Cathy drank coffee using the DLR Light-Weight Robot III arm, developed at the German Aerospace Center. This

New technology turns a person’s thoughts into actions, such as directing this robotic arm to pick up a bottle of coffee.

J. DONOGHUE *ET AL*

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

robotic limb is designed to work independently. She and Bob, a second study participant, used thoughts to control the DEKA Arm System, a prototype of a prosthetic that could substitute for a lost limb.

The trials began with a calibration step. The researchers had both Cathy and Bob watch the robotic arm do various movements and then imagine that they were doing the movements themselves. The computer then knew to interpret a particular pattern of nerve cell activity as a particular movement. After half an hour of calibrating, Cathy and Bob did several runs using their thoughts to get the robotic arms to reach out and grasp foam balls on dowels of various heights.

"I think about moving my hand and wrist. I'm right-handed, so it's very comfortable and feels natural to imagine my right hand moving in the direction I want the robotic arm to move," Cathy said when asked how she does it. Cathy succeeded in grasping the target in 48.8 percent of her DLR arm trials and in 69.2 percent of her DEKA arm trials. Bob had success in 95.6 percent of his trials using the DEKA arm.

The robotic arm movements are still pretty clunky, says neuroscientist John Kalaska of the University of Montreal. But the new demonstration is a significant advance, he says. For one thing, Cathy's sensor was implanted in her brain more than five years ago. The investigators didn't know for sure whether scar tissue might build up around the implant, rendering Cathy's thoughts unreadable.

A tiny chip implanted in a paralyzed woman's brain enabled her to move a robotic arm with her thoughts (left). When she thought about moving her paralyzed arm, the chip (right) detected the pattern of nerves firing in her brain; a computer translated those signals into actions carried out by the robotic arm.

And the new demonstration is a big step forward from using thoughts to move a cursor on a computer screen, BrainGate's big news reported in 2006 (*SN: 7/2/11, p. 26*).

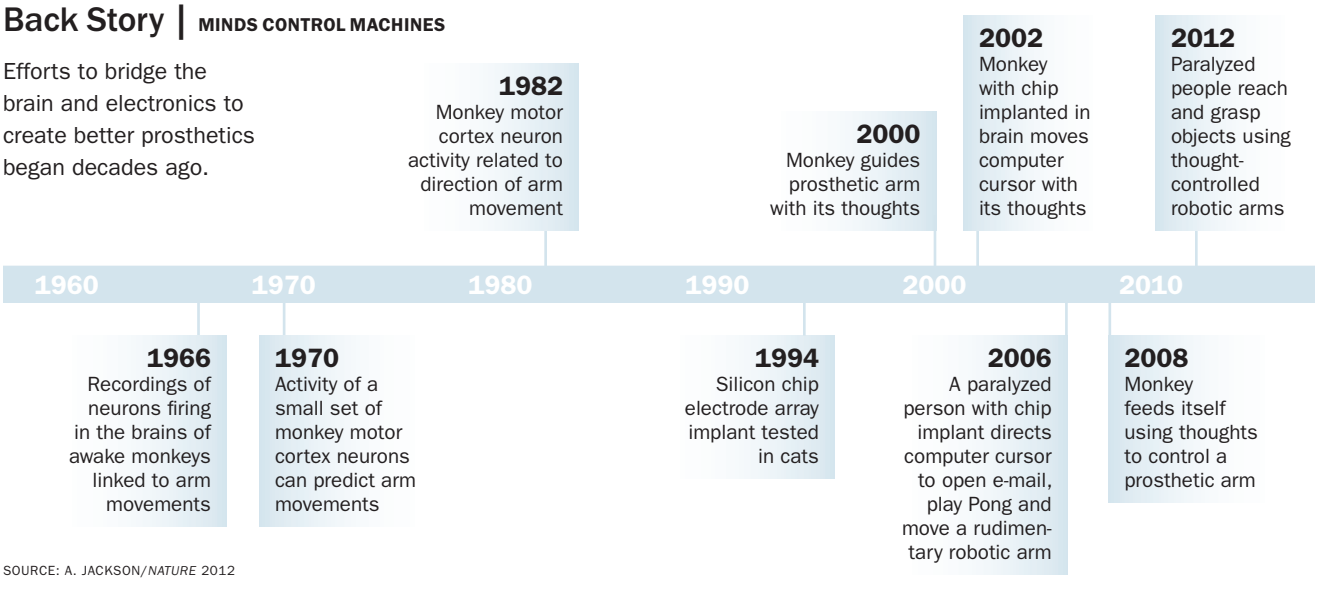
Since then, the algorithms that decode the brain signals have gotten a lot better, says neuroscientist John Donoghue, also of Brown and the original developer of BrainGate.

The research team is still figuring out how much functionality should be incorporated into the robotic limbs.

"The brain basically says, 'OK hand, go out and reach for something,'" says Donoghue. Future work will improve the robotic limbs so they fill in more of the details of a task the same way the nerves in an arm do. ■

Back Story | MINDS CONTROL MACHINES

Efforts to bridge the brain and electronics to create better prosthetics began decades ago.



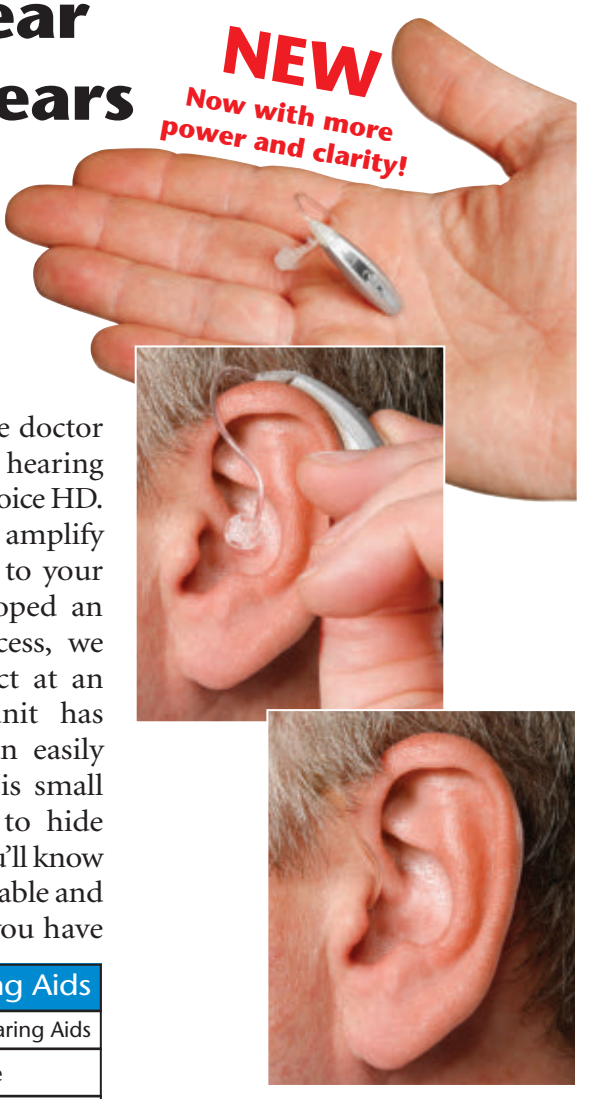
SOURCE: A. JACKSON/*NATURE* 2012

FROM LEFT: J. DONOGHUE *ET AL*.; BRAINGATE2.ORG

The invention of the year is great news for your ears

Perfect Choice HD™ is easy to use, hard to see and costs far less than hearing aids… it's like reading glasses for your ears™!

New Personal Sound Amplification Product is an affordable alternative



Over the years, technology has made the way we live easier, safer and more convenient. In many cases, it's even made many products more affordable… (remember how much the first VCRs used to cost?). Unfortunately, the cost of hearing aids never seemed to come down. Now, a new alternative has been invented… it's called Perfect Choice HD™.

"Reading glasses for your ears"

Perfect Choice HD is NOT a hearing aid. Hearing aids can only be sold by an audiologist. In order to get a hearing aid, you had to go to the doctor's office for a battery of tests and numerous fitting appointments. Once they had you tested and fitted, you would have to pay as much as $5000 for the product. Now, thanks to the efforts of the doctor who leads a renowned hearing institute, there is Perfect Choice HD. It's designed to accurately amplify sounds and deliver them to your ear. Because we've developed an efficient production process, we can make a great product at an affordable price. The unit has been designed to have an easily accessible battery, but it is small and lightweight enough to hide behind your ear… only you'll know you have it on. It's comfortable and won't make you feel like you have something stuck in your ear. It provides high quality audio so sounds and conversations will be easier to hear and understand.

Perfect Choice HD vs Traditional Hearing Aids

	Perfect Choice HD	Traditional Hearing Aids
Lightweight and Inconspicuous	YES	Some
Easy Toggle Switch Adjustment	YES	Few
Intelligent Setting Memory	YES	Few
Tests and Fittings Required	NO	Yes
Affordable	YES	as much as $5000
Friendly Return Policy	**YES**	**rarely**

Affordable, Simple to use, Virtually impossible to see

Try it for yourself with our exclusive home trial. Some people need hearing aids but many just need the extra boost in volume that a PSAP gives them. We want you to be happy with Perfect Choice HD, so we are offering to let you try it for yourself. If you are not totally satisfied with this product, simply return it within 60 days for a refund of the full product purchase price. Don't wait… don't miss out on another conversation… call now!

Are you or a loved one frustrated in these situations?

• Restaurants • Dinner parties
• Outdoor conversations
• Lectures • Sermons
• Meetings
…and other times where you need to turn up the volume

Perfect Choice HD™

Call now for the lowest price ever.

Please mention promotional code 44694.

1-877-725-6450

Perfect Choice HD is not a hearing aid. If you believe you need a hearing aid, please consult a physician.

80326

ADVERTISEMENT

Science & Society

For more Science & Society stories, visit **www.sciencenews.org**

Cancer project takes top award at science fair

Winners at Intel competition collect $3 million in prizes

By Devin Powell

PITTSBURGH — New ways to detect cancer, search online social networks and link atoms using quantum physics took the highest honors at the Intel International Science and Engineering Fair 2012.

Over the course of a week, 1,549 finalists presented their research to judges. Winners divvied up more than $3 million in awards, with the top prizes announced May 18. Society for Science & the Public, or SSP, runs the competition, the largest international precollege science fair.

"As a group, you are a force for profound good," SSP president and publisher of *Science News* Elizabeth Marincola told the finalists. "Your innovative thinking can help humanity adopt more effective responses to natural and man-made disasters, transition to safer and smarter vehicles, and discover new ways of treating and preventing disease."

Jack Andraka, 15, claimed the top prize of $75,000, given in honor of Intel cofounder Gordon E. Moore. A family tragedy motivated Andraka, from Crownsville, Md., to create strips of paper that can help detect pancreatic cancer.

"My uncle died of pancreatic cancer 10 months ago," Andraka said.

High levels of a protein called mesothelin in the blood can reveal the presence of pancreatic cancer tumors. But the lack of a quick, cheap diagnostic test for the protein means the disease tends to be caught late, making it especially lethal.

Searching for a better detector for mesothelin, Andraka coated paper with tiny tubes of atom-thick carbon. Antibodies stuck to the carbon nanotubes can grab the telltale protein and spread the tubes apart. The carbon's resistance to the flow of electricity drops as more protein attaches. Tests using blood samples from 100 people with cancer at different stages identified the presence of cancer every time, Andraka reported.

Winners of the top awards at this year's Intel International Science and Engineering Fair celebrate during a ceremony on May 18. From left: Ari Dyckovsky, first place winner Jack Andraka and Nicholas Schiefer.

Nicholas Schiefer, a 17-year-old from Pickering, Canada, received the Intel Foundation's $50,000 Young Scientist Award for a new way to search Twitter tweets, Facebook status updates and other small Web documents. Algorithms trying to sift through such piles of information tend to use each keyword entered for the search in isolation. Schiefer linked keywords to other related words, connecting "Fukushima" to "earthquake" and "nuclear disaster," for instance.

"What I've developed could be a piece of a commercial search engine," said Schiefer, who added that such engines typically use many algorithms working in concert.

A Young Scientist Award also went to Ari Dyckovsky, 18, from Leesburg, Va. His work to push forward computers with quantum physics earned him a spot as a finalist earlier this year at the Intel Science Talent Search in Washington, D.C. That competition is also run by SSP.

Dyckovsky's idea is to use a phenomenon called quantum entanglement to speed up the process of transferring quantum information. His research, which will be published in an upcoming issue of *Physical Review A*, could also give a boost to hybrid systems that join individual atoms to clumps of atoms called quantum dots.

Each of the top projects also won a Best of Category award and $5,000 from Intel. So did 14 other projects in categories ranging from animal sciences to mathematics. First place and second place winners in each category received $3,000 and $1,500, respectively.

Other students' projects earned them free trips to distant places. Assiya Kussainova, 16, from Karaganda in Kazakhstan, will travel to the European Union Contest for Young Scientists in Bratislava, Slovakia. She invented a wind turbine that can spin and produce energy even in slow air currents.

Noticed for a filter that spares lungs from organic compounds in the air, 16-year-old Naomi Shah from Portland, Ore., will join Kussainova. So will another 16-year-old Portlander: Raghav Tripathi, who studied two molecules that build up in the brains of people with Alzheimer's disease. He showed that the two molecules can stick together and found ways to disrupt that interaction.

Three other students will travel to the Stockholm International Youth Science Seminar and attend the Nobel Prize ceremony as winners of the Dudley R. Herschbach SIYSS Award. Herschbach received the 1986 Nobel Prize in chemistry and is emeritus board chair of SSP.

Raghavendra Ramachanderan, a 17-year-old from Chennai, India, earned his voyage to Sweden by creating catalysts for regenerating spent fuel. SIYSS prizewinner Adam Noble recruited algae to remove 99.99 percent of the dissolved silver coming from a water treatment plant.

The third SIYSS recipient, Huihui Fan of New York City, discovered a gene that helps to control the size and number of roots. Disrupting the gene produces plants with stunted roots, helpful for plants grown in contaminated soil.

© INTEL

49.3 percent | U.S. burglary victims saying they reported it, 1999

57.3 percent | U.S. burglary victims saying they reported it, 2009

58.8 percent | U.S. burglary victims saying they reported it, 2010

Reliance on raw statistics makes city crime rankings misleading

Analyses should consider uncertainties, criminologists say

By Rachel Ehrenberg

Overconfidence in crime statistics doesn't pay.

In a new study, a team of criminologists makes the case that reported crime rates should acknowledge uncertainty in the data. The research demonstrates that rankings of cities as safer or more dangerous — which can influence tourism and tax spending — can be highly misleading.

"If you look at crime rates from year to year and you see a change, there's a fundamental ambiguity in whether that change is caused by a real change in crime, a change in reporting or some of both," says criminologist Robert Brame of the University of North Carolina at Charlotte, a coauthor of the new study. "Our position is we should own that. There's ambiguity here and we should learn to deal with it."

To get a sense of that ambiguity, Brame and his colleagues calculated the wiggle room in burglary data for the 10 biggest cities in North Carolina for 2009 and 2010. Based on state population estimates and the residential burglaries reported by police departments, the standard simple calculation suggests that in 2009 Wilmington had a higher residential burglary rate than Charlotte, for example. But when the researchers included known uncertainties in the numbers, Charlotte was too close to Wilmington to discern if one really had a lower or higher burglary rate than the other. Ambiguity in the data also meant that the researchers couldn't tell if the rate of burglaries in, say, Raleigh and Winston-Salem had dropped or risen from 2009 to 2010. Brame, University of North Carolina colleague Michael Turner and Raymond Paternoster of the University of Maryland in College Park reported their analysis online April 30 at arXiv.org.

A major source of uncertainty lies in how many crimes are actually reported. Researchers investigated the issue using two sources of data: hard numbers of reported crimes and estimates of how many crimes go unreported. The hard numbers came from state data compiled for the FBI's Uniform Crime Reports. For residential burglaries, these numbers are known to be underestimates: If a burglary occurs along with a more serious crime, such as aggravated assault, rape or murder, the incident will be recorded as the higher-ranking offense.

For estimates of unreported burglaries, the researchers turned to the National Crime Victimization Survey of the Bureau of Justice Statistics, which compiles yearly data from interviews with roughly 40,000 households on their experience with crime and whether they reported crimes they encountered.

The NCVS survey data suggest that the national rate at which residential burglaries are reported to the police varies, but has increased in recent years. In 1999, for example, 49.3 percent of victims said the crime had been reported. In 2009, 57.3 percent of burglary victims said the event had been reported, and in 2010, 58.8 percent did.

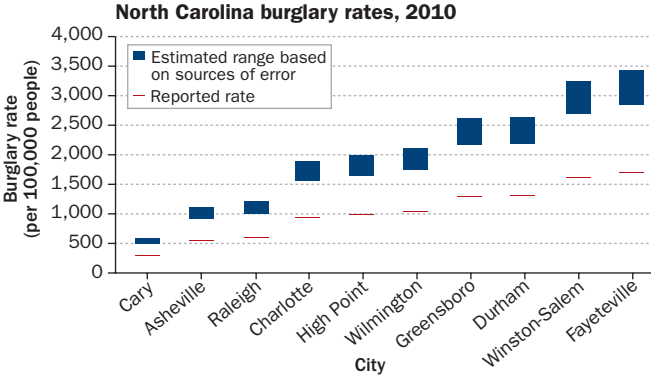
A major factor affecting these numbers is a community's perception of and relationship to the law, says sociologist David Kirk of the University of Texas at Austin. Some communities perceive the police as helpful; others see the police as out to get them. This means that more crimes might be reported in a community that trusts its police department, giving the impression that the community has more crime.

Using the data on burglaries that go unreported, Brame and colleagues gave their estimates an upper and lower bound. They also accounted for uncertainty in city size, since population estimates by states often differ from federal numbers. The researchers argue that presenting crime data as an interval offers more meaningful information about whether a particular crime intervention strategy or youth education program is working, even if the answer is "we don't know."

Criminologist Richard Rosenfeld of the University of Missouri in St. Louis, who has spent years studying crime trends, says more such studies are needed. Not only are the numbers often fuzzier than they appear, but within a city, crime varies greatly across neighborhoods. The best predictors of whether people are at risk for crime isn't the city they live in, says Rosenfeld, but factors such as age, gender and whether the person is involved in criminal activity. ■

Keeping up with crime Using raw crime statistics to rank cities according to safety can give a false impression. Including the rate of unreported crimes and other measurable sources of error offers a fuller view, criminologists argue.

SOURCE: R. BRAME *ET AL*/ ARXIV.ORG 2012



Humans

For longer versions of these and other Humans stories, visit **www.sciencenews.org**

When good moods go decisively bad

Positive feelings can lead to poor choices among seniors

By Bruce Bower

Feeling peppy may lead older adults to settle for less. In a new study, seniors in a good mood compared fewer options and made worse choices than did younger participants or those in a bad mood.

"Positive emotions may have costs for older adults' decision making," says study coauthor Bettina von Helversen, a psychologist at the University of Basel in Switzerland.

A bright mood makes it harder to select a quality option from a series of choices, such as finding a bargain on a new computer offered at different prices by various online sites, say von Helversen and University of Basel colleague Rui Mata.

Though the study looked at comparing prices on products, picking from a series of choices — what psychologists call sequential decision making — also comes into play in situations such as choosing an apartment, hiring a caretaker or selecting a mate.

Past research has found that people's moods tend to improve as they age. This good mood, perhaps more than intellectual declines, may undermine seniors' sequential decisions by promoting a limited search of options, the researchers report in an upcoming *Psychology and Aging*.

> "Positive emotions may have costs for older adults' decision making."
>
> BETTINA VON HELVERSEN

These new findings fit with evidence that positive moods can either hinder or help older adults' decisions, says psychologist Lynn Hasher of the University of Toronto. On the plus side, seniors often have a clear preference for familiar purchases such as cars, which cuts down on product searches and yet still yields satisfying picks.

In their investigation, von Helversen and Mata asked 64 volunteers — half in their early 20s and half around 70 years old — to use a computer to shop for the best price on 60 products in a task set up to model Internet shopping. Participants could view up to 40 different prices, one at a time, for items that included computer monitors and refrigerators. But participants were not allowed to peruse all prices and then decide — once they had passed over an option it was no longer available.

Overall, older adults considered fewer options before making choices and so selected higher-priced products than younger adults did.

Only elderly volunteers reported high levels of enthusiasm and other positive feelings before testing. Upbeat moods peaked among individuals who viewed the fewest items on the shopping task. Scores on vocabulary and problem-solving tasks showed no relationship to price-shopping success.

In a separate test, young adults shown mood-boosting images before doing price comparisons perused fewer products than same-age participants shown neutral pictures.

Von Helversen and Mata did not measure volunteers' working memory, the ability to juggle different pieces of information at once. Declining working memory in older adults probably makes it harder to profit from examining options in a sequence, von Helversen says.

TYRONE TURNER, © 2012 NATIONAL GEOGRAPHIC

Maya wall calendar found

Astronomical tables dating to the Maya civilization's golden age have come to light inside a roughly 1,200-year-old room in Guatemala. Hieroglyphs and numbers painted on the walls of a structure built during the Classic Maya civilization record cycles of the moon, and possibly Mars, Venus and Mercury, Boston University archaeologist William Saturno and his colleagues report in the May 11 *Science*. The paintings also include human figures (left) that may represent a king talking to a kneeling attendant, says David Freidel of Washington University in St. Louis. Until now, Maya astronomical tables were known from a bark-paper book known as the Dresden Codex and created 400 years or more after the ancient civilization's decline around 900. Similarities between the newfound paintings and the Dresden Codex suggest that the Maya passed and revised astronomical information over many generations after the Classic collapse, Saturno says. —*Bruce Bower*

Numbers

"Even if you don't have perfect randomness, you can make perfect randomness." —ROGER COLBECK

Physicists go totally random

Quantum trick offers way to eliminate number patterns

By Alexandra Witze

Casino bosses, take note: Physicists have described a way to guarantee complete randomness in a flow of information, such as the numbers generated by a roulette wheel.

The method could transform a stream of not-quite-random information into a totally random one. "Even if you don't have perfect randomness, you can make perfect randomness," says physicist Roger Colbeck of ETH Zurich in Switzerland. "This is sort of a guarantee given to you by the laws of physics." Colbeck and Renato Renner of ETH describe the finding online May 6 in *Nature Physics*.

True randomness — in which a coin flip has a 50 percent chance of coming up heads — is hugely important in fields such as cryptography. In a code based on less than random numbers, patterns could be detected, allowing it to be broken. And if a casino's random number generators aren't absolutely random, a gambler might be able to exploit that weakness.

Colbeck and Renner wanted to better understand the role of randomness in quantum physics. In quantum theory, two particles can be mysteriously linked, or entangled, with one another such that measuring a property of one instantly determines the same property in the other, even if the particles are separated by vast distances. Physicists often assume that the measurements on these particles are chosen randomly to start with.

In the new work, the scientists have calculated what might happen to a stream of partially random information, in which some of the bits are correlated with other variables, making the bits not random. By using these bits to choose measurements on pairs of entangled particles sent down separate paths, an outcome can be produced that is independent of any other variables, producing perfectly random bits, Colbeck and Renner show.

"Imagine an adversary who can guess at what choice you're going to make," says Colbeck. "We've shown there's a procedure where you can make it so the adversary cannot guess at all, within certain limits. In principle, one could use this to make better-quality random numbers."

Nicolas Gisin, a physicist at the University of Geneva, says "the fact that the quality of randomness can be improved is new and surprising." He says researchers might next explore exactly how not-random the information flow can be and still be made purely random. ■

ADVENTURES IN SCIENCE

EINSTEIN'S JEWISH SCIENCE
Physics at the Intersection of Politics and Religion
Steven Gimbel
$24.95 hardcover

THE SCIENCE OF NAVIGATION
From Dead Reckoning to GPS
Mark Denny
$30.00 paperback

THE PRACTICAL EINSTEIN
Experiments, Patents, Inventions
József Illy
$60.00 hardcover

WOMEN SCIENTISTS IN AMERICA
Volume 3: Forging a New World since 1972
Margaret W. Rossiter
$45.00 paperback

POLAR BEARS
A Complete Guide to Their Biology and Behavior
Text by Andrew E. Derocher
Photographs by Wayne Lynch
$39.95 hardcover

A TOUR OF THE SENSES
How Your Brain Interprets the World
John M. Henshaw
$29.95 hardcover

TREES OF LIFE
A Visual History of Evolution
Theodore W. Pietsch
$69.95 hardcover

DEER
The Animal Answer Guide
George A. Feldhamer and William J. McShea
$24.95 paperback

SECRET LIVES OF ANTS
Jae Choe
foreword by Jane Goodall
photographs by Dan Perlman
$34.95 hardcover

VERTEBRATE BIOLOGY
second edition
Donald W. Linzey
$110.00 hardcover

PLANTS OF THE CHESAPEAKE BAY
A Guide to Wildflowers, Grasses, Aquatic Vegetation, Trees, Shrubs, and Other Flora
Lytton John Musselman and David A. Knepper
$24.95 paperback

VENOMOUS REPTILES OF THE UNITED STATES, CANADA, AND NORTHERN MEXICO
Volume 2: *Crotalus*
Carl H. Ernst and Evelyn M. Ernst
$75.00 hardcover

MATH GOES TO THE MOVIES
Burkard Polster and Marty Ross
$35.00 paperback

GOLF BY THE NUMBERS
How Stats, Math, and Physics Affect Your Game
Roland Minton
$34.95 hardcover

WAVELETS
A Concise Guide
Amir-Homayoon Najmi
$45.00 paperback

MATHEMATICAL EXPEDITIONS
Exploring Word Problems across the Ages
Frank J. Swetz
$30.00 paperback

THE WILDLIFE TECHNIQUES MANUAL
Volume 1: Research
Volume 2: Management
seventh edition
edited by Nova J. Silvy
$150.00 hardcover, 2-vol. set

THE JOHNS HOPKINS UNIVERSITY PRESS
1-800-537-5487 • press.jhu.edu

Body & Brain

For longer versions of these and other Body & Brain stories, visit **www.sciencenews.org**

Implants could restore eyesight

Tests in rat retinas show feasibility of laser system

By Rachel Ehrenberg

Specialized goggles that send information to solar cell–like chips implanted in the eyes may one day help some blind people see. The implants, which have been tested in rat retinas in a dish, would require less invasive surgery than similar devices now being tested in people and offer a higher-resolution view of the world.

The new system, reported online May 13 in *Nature Photonics*, still needs work before being tested in people. But someday it may return partial sight to people suffering from conditions such as retinitis pigmentosa, an inherited disease that can lead to night blindness and tunnel vision, or macular degeneration, in which sharp central vision is lost but peripheral vision remains.

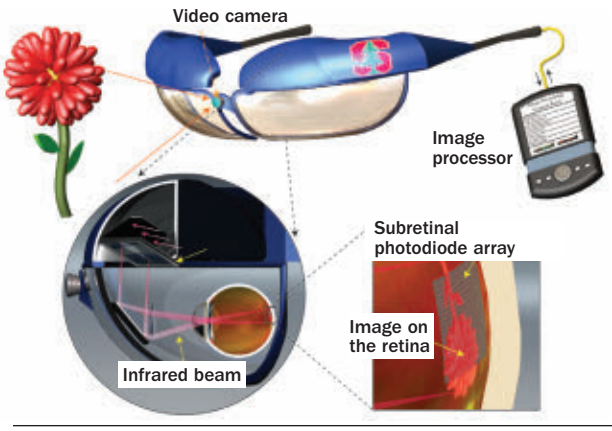
In those conditions, vision suffers when light-detecting cells at the back of the eye are damaged, even though the nerve cells that send visual information to the brain may remain intact.

No current treatments can fully restore vision for such retinal damage, says eye specialist Lotfi Merabet of Massachusetts Eye and Ear in Boston. The new work "is certainly very promising," he says.

Developing the implants took many years, says study coauthor James Loudin of Stanford University. "The sheer number of new technologies that had to be developed — it's amazing."

For starters, there are the goggles. A miniature video camera sits on the nosepiece. Information from the camera streams to a portable computer about the size of a smartphone. This computer processes the images, which are projected into the eyes by infrared lasers inside the goggle lenses. The laser beams hit slender photovoltaic chips implanted beneath the retinas, which convert the light into electrical current, stimulating nerve cells that send information to the brain.

Other labs have designed retinal prostheses, but these systems transmit information and power via coils and wiring that have to be surgically implanted along with the retinal chip. Most of the hardware for the new prosthetics is in the goggles, so only the thin solar cell–like chip needs to be implanted.



Bionic eye A system being tested at Stanford University may partially restore sight for some blind people. A handheld computer processes images from a video camera that sits on specialized goggles. Lasers inside the goggles send that information to photovoltaic chips implanted beneath the retina, stimulating nerve cells that send information to the brain. The person then perceives the images seen by the camera.

Moderate noise may harm hearing

Rat brains altered by chronic, low-level sound exposure

By Rebecca Cheung

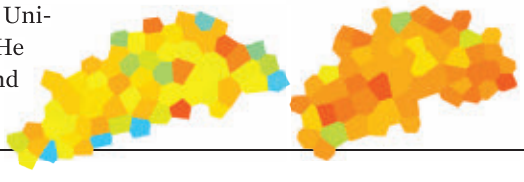
Constant low-level noise might cause hearing problems, a new study in rats finds. The discovery, published online May 15 in *Nature Communications*, suggests that extended exposure to noise at levels usually deemed safe for human ears could actually impair sound perception.

The findings are "definitely a warning flag," says study coauthor Michael Merzenich, a neuroscientist at the University of California, San Francisco. He adds that it will be important to find out whether people employed at factories where continuous low-intensity noise is emitted throughout the workday experience similar consequences.

Sustained exposure to louder noises — above 85 decibels — or brief exposures to noises above 100 decibels can cause inner ear damage and hearing impairments. But the impact of chronic, quieter sound hasn't been well studied.

In the new study, Merzenich and Xiaoming Zhou of East China Normal University in Shanghai exposed adult rats to 65 decibel sound — roughly at the higher end of normal human speech volume — for 10 hours daily.

After two months, noise-exposed rats did not perform as well on listening tests as animals that lived a quieter life. The noise-exposed rats also had fewer nerve cells that are involved in detecting sharp sound, suggesting that their brains are being altered by sound conditioning.



Maps of the brain's auditory cortex, which processes sound, show that rats exposed to low-level noise have fewer nerve cells that respond to highly pulsed sound patterns (orange).

FROM TOP: K. MATHIESON *ET AL*/*NATURE PHOTONICS* 2012; X. ZHOU AND M. MERZENICH/*NATURE COMMUNICATIONS* 2012

Mystery neurons found in monkey

Von Economo cells may offer clues to consciousness

By Laura Sanders

A mysterious kind of nerve cell that has been linked to empathy, self-awareness and even consciousness resides in Old World monkeys.

The finding, published in the May 10 *Neuron*, extends the domain of these neurons beyond humans, great apes and other large-brained creatures and will now allow scientists to study the habits of a neuron that may be key to human self-awareness.

"People have been reluctant to say, but want to believe, that these neurons might be the neural correlate of consciousness," says neuroscientist and psychiatrist Hugo Critchley of the University of Sussex in England. Finding the neurons in macaques, which can be studied in laboratories, "opens up the possibility to study directly the role of these cells," he says.

> **"People ... want to believe these neurons might be the neural correlate of consciousness."**
> HUGO CRITCHLEY

An earlier study saw no signs of the cells, called von Economo neurons, in macaques. But while carefully scrutinizing a small piece of a macaque brain for a different experiment, anatomist Henry Evrard of the Max Planck Institute for Biological Cybernetics in Tübingen, Germany, stumbled across the rare, distinctive cells. About three times bigger than other nearby nerve cells, von Economo neurons have long, fat bodies and tufts of message-receiving dendrites at each end.

Evrard compares the first sighting to seeing the tip of an iceberg. After many additional tests, he and his colleagues concluded that the cells, though smaller and sparser than their human counterparts, were indeed the elusive von Economo neurons.

No one knows what these hulking, strangely shaped neurons do, but scientists have hints that the job may be very important. One reason for this assumption is that, initially, von Economo neurons were found exclusively in big-brained animals with complex social lives: people, great apes, elephants, whales and dolphins, for instance. (A recent sighting in zebras' brains presented a puzzle.)

In people, von Economo neurons are located in the anterior insula and anterior cingulate cortex, hubs in the brain for empathy and self-awareness. And when the neurons die off, as they do in a rare form of dementia, people lose their capacity for relating to others.

Finding these cells in similar brain regions in monkeys could present a blow to the idea that the cells bestow self-awareness. Although it's difficult to assess a monkey's state of mind, macaques don't reliably recognize themselves in a mirror, one simple test of self-awareness.

In the macaque, the location of the von Economo neurons suggests they may handle a more basic kind of bodily awareness. The anterior insula helps the brain sense internal states such as hunger, stress or pain. "The von Economo neurons may play a more sophisticated role in humans," says Evrard.

The results have clinical implications, says William Seeley of the University of California, San Francisco, who recently discovered that von Economo neurons are selectively lost in people with a certain type of frontotemporal dementia that affects empathy and self-awareness. Learning more about the neurons' behavior in macaques may help scientists understand what goes wrong in particular human diseases. ■

The Great Pheromone Myth

directly challenges ideas about the role chemicals play in mammalian behavior and reproductive processes.

It is a must-have reference for biologists, psychologists, neuroscientists, and readers interested in animal behavior, ecology, and evolution.

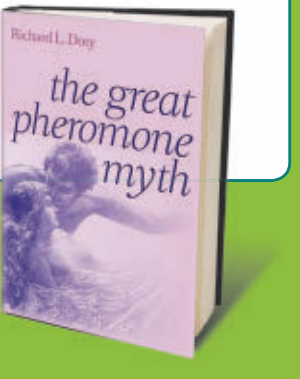
JOHNS HOPKINS UNIVERSITY PRESS

SENSONICS, INC.

SENSONICS, INC
(800) 547-8838
(856) 547-7702 (outside USA)
sales@sensonics.com

www.sensonics.com

P.O. Box 112
Haddon Heights, NJ
08035-0012 USA



Genes & Cells

For longer versions of these and other Genes & Cells stories, visit **www.sciencenews.org**

Good cholesterol not so beneficial

Higher HDL levels don't reduce heart attacks, study finds

By Tina Hesman Saey

Some shine may have worn off "good" cholesterol's halo. A new genetics study shows that merely raising levels of high-density lipoprotein — also known as HDL or good cholesterol — does not protect against heart attacks.

That finding contrasts sharply with population studies showing that people with high levels of HDL have a lower than average risk of heart attack. The new results, published online May 17 in the *Lancet*, may mean that blood levels of good cholesterol serve as indicators of some other biological process that protects the heart, and that HDL itself is not directly involved in heart health.

Doctors often use measurements of two types of cholesterol in the blood to identify patients at higher risk for heart attacks. Data from large studies show a consistent pattern: People with high levels of low-density lipoprotein, called LDL or bad cholesterol, stand a greater than average chance of having a heart attack. Those data have been backed up by drug studies showing that lowering LDL levels also lowers heart attack risk.

But the case for HDL has been less clear. "As a predictor, HDL is perfect. It's unequivocal," says Benjamin Voight, a geneticist at the University of Pennsylvania in Philadelphia and coauthor of the new study. Yet drugs that raise HDL haven't performed well in clinical trials. On May 7, the drug company Roche announced that a trial of dalcetrapib, an HDL-boosting drug, had been stopped because it was not effective.

> "Maybe HDL is not what we should be worried about as such."
> RUTH LOOS

Losing weight, stopping smoking and increasing exercise — all actions that boost HDL levels — also improve other heart disease risk factors. That has made it difficult to tease out just how protective HDL is on its own. To find out, Voight and colleagues compiled data from earlier studies on more than 116,000 people, including more than 20,000 who had suffered heart attacks. About 2.6 percent of those studied carry a mutation that raises HDL levels, on average, about 7 milligrams per deciliter over levels in people without the mutation. That HDL increase was expected to lower the mutation-carriers' heart attack risk by 13 percent.

"But surprise, we didn't find that," says study coauthor Sekar Kathiresan, a cardiologist and geneticist at the Broad Institute of MIT and Harvard. People genetically endowed to make higher levels of HDL didn't have a lower risk of heart attack.

To make sure the result wasn't a fluke, the researchers compiled a genetic score for 53,813 people based on how many of 14 other HDL-boosting genetic variants the person carried. People with the highest genetic score, and thus the highest HDL, weren't protected from heart attack.

"To me the results are really credible and very convincing," says Ruth Loos, a genetic epidemiologist at Mount Sinai School of Medicine in New York City. "Maybe HDL is not what we should be worried about as such."

Death hour may depend on DNA

Active times, reaper's arrival linked to biological clock gene

By Rebecca Cheung

Biological clock settings might provide clues to when during the day a person will be more active. And these same settings could be linked to what time of day a person will die, a new study finds.

Understanding the biological basis of these built-in daily, or circadian, clocks "could lead to products that eventually allow us to shift the clock forwards or backwards," says Philip De Jager, a neurologist at Harvard Medical School. He and his colleagues describe their work online April 26 in *Annals of Neurology*.

Altering these clocks could prove useful for shift workers, such as pilots, who might face trouble working against their intrinsic daily rhythms. And patients can be better cared for if doctors know what times of day are most critical.

Scientists have previously shown that many genes are involved in regulating people's inherent daily wake and sleep patterns. Disruptions to this natural circadian rhythm are often linked to serious health conditions, including diabetes.

In the new work, De Jager's team found two versions of a piece of DNA associated with *PER1,* a circadian clock–regulating gene. In DNA samples collected from 537 older adults of European ancestry, the team found that the two DNA versions were associated with certain times of the day when a person was most active.

PER1 also appeared to be linked to a person's time of death, scientists found after analyzing a larger sample of 712 older people. Patients with one kind of tweak near the gene tended to die earlier in the day, at about 11 a.m., while others with a different tweak tended to pass away hours later, at about 6 p.m.

Deaths linked to certain hours of the day aren't unusual, says Satchin Panda of the Salk Institute for Biological Studies in La Jolla, Calif. *PER1*-associated variations "might be weakening one or multiple organs that need to crank up at certain times of the day," Panda says.

97 Rwandans in study with PTSD who had a genetic signature for strong memory

37 Rwandans in study with PTSD who did not have the genetic signature

Better memory, worse trauma

Genetic signature related to recall linked to risk of PTSD

By Laura Sanders

A certain genetic signature may give some people the ability to form stronger memories. But that edge also has a dark side: increased risk of post-traumatic stress disorder.

Although the genetic effect is small, new results help scientists better understand the link between especially powerful memories and sensitivity to past trauma.

Dominique de Quervain, a neuroscientist at the University of Basel in Switzerland, and colleagues looked at how genetic differences related to performance on a memory task. A group of 723 healthy young Swiss adults viewed 72 photographs. After a 10-minute wait, the volunteers were asked to remember as many images as possible.

Volunteers who could remember more pictures carried a particular DNA signature in at least one copy of a gene that encodes protein kinase C alpha. In animal studies, this protein has been shown to play a role in the formation of emotional memories. The volunteers' heightened recall was true for disturbing, pleasant and neutral pictures.

Further evidence came from brain scans performed in a different group of Swiss people. While viewing the pictures, people with the genetic signature had stronger brain activation in parts of the prefrontal cortex than those who lacked the genetic feature, the researchers report online May 14 in the *Proceedings of the National Academy of Sciences*.

Because memory is known to be an important part of PTSD, de Quervain and his team wanted to see if their results might have importance beyond the laboratory. The researchers looked at the genes of 347 people who had survived the brutal 1994 Rwandan genocide and now live in a refugee camp in Uganda. The genocide was marked by extreme violence and war rape. About a third of those studied met the clinical criteria for PTSD.

Among the Rwandan refugees, having the strong-memory genetic signature was linked to a roughly doubled risk of PTSD compared with the rate among those without the signature. The signature was relatively rare in the Rwandan population, even though it was almost universal among the Swiss.

"I think this work is of great theoretical interest," says PTSD researcher Roger Pitman of Massachusetts General Hospital and Harvard Medical School. The study supports the idea that stronger memories are linked to a heightened risk of PTSD, a theory that's been discussed but hasn't had much evidence, he says. "This is another piece of the puzzle."

The results explain only a small sliver of memory formation and PTSD. "But that doesn't mean this gene isn't important," de Quervain says. The results give a deeper understanding of how strong memories relate to diseases such as PTSD, he says. Studying the role of protein kinase C alpha may reveal more about how memories form and perhaps even why some prove so troubling. ■

Genes play role in body's bacteria

DNA variations associated with different mix of microbes

By Tina Hesman Saey

COLD SPRING HARBOR, N.Y. — Microbes aren't completely the boss of their human hosts. People's genes may have a say in which microbes come to live in and on the human body, a new study suggests.

Recent research has shown that the mix of microbes colonizing a person's body is associated with some diseases. But exactly what determines which microbes settle in or on a particular human host has been a mystery. Diet and geography are partly responsible; human genetics' role has been unclear. "We know there is a genetic component," says Ran Blekhman, a geneticist at Cornell University. "We're just not sure how big it is."

To find out, Blekhman and colleagues used data on bacterial and human DNA from the Human Microbiome Project. Comparing human and bacterial DNA revealed 51 different human genetic variants associated with the relative abundance of certain bacteria living in or on 15 body sites. Some of those genetic variants and the microbes they were associated with have also been linked to diseases. People with a genetic variant near the *PCSK2* gene, which is involved in producing insulin, have more *Bacteroides* bacteria in their intestines, Blekhman reported May 9 at the Biology of Genomes meeting. That same genetic variant has been linked to type 2 diabetes. So has an overabundance of *Bacteroides*.

Gut bacteria such as *Bacteroides* (*B. fragilis* shown) are more abundant in people with a particular genetic variant, a new study shows.

CNRI/PHOTO RESEARCHERS, INC.

People who have a version of the *CXCL12* gene previously associated with inflammatory diseases also carry more *Granulicatella* bacteria on their skin. Those bacteria have previously been linked to inflammation.

Atom & Cosmos

Superflares' trigger a mystery

Stellar surface explosions may not need 'hot Jupiters'

By Nadia Drake

Not just a sartorial trend in '70s trousers, superflares are enormous stellar eruptions that dwarf the most energetic sneeze the sun is likely to produce.

Astronomers have thought these outbursts resulted from magnetic interactions between a star and a tightly orbiting, and therefore hot, Jupiter-sized planet. But data from NASA's Kepler spacecraft suggest that while a magnetic trigger does ignite mega-eruptions on sunlike stars, snuggled-up Jupiters don't appear to be necessary, scientists from Japan report online May 16 in *Nature*.

"The default picture of these has been hot Jupiters," says Bradley Schaefer, an astrophysicist at Louisiana State University. "There's no alternative out there."

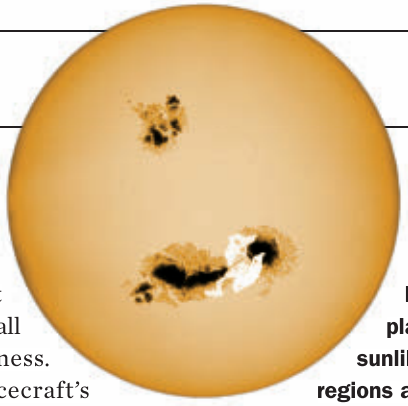
Perhaps, Schaefer speculates, a much smaller and harder to detect planet could provoke a superflare in its stellar host.

Studying superflares is hard: They're transient, infrequent and produce only a small difference in brightness. But the Kepler spacecraft's view of 160,000 stars makes it optimal for detecting these outbursts.

Using data from Kepler, a team of astronomers from Japan's Kyoto University studied fluctuations in brightness of roughly 83,000 solar-type stars. Over 120 days, the researchers saw evidence for 365 superflares on 148 stars, with the average eruption lasting a few hours. The twinkling starlight revealed that stars with starspots — the equivalent of magnetically hyperactive sunspots — produced the flares. "These stars have large starspots, which are much larger than those of our sun," says astronomer and study coauthor Hiroyuki Maehara.

But Maehara and colleagues didn't detect any planetary signatures in the peaks and valleys of starry light.

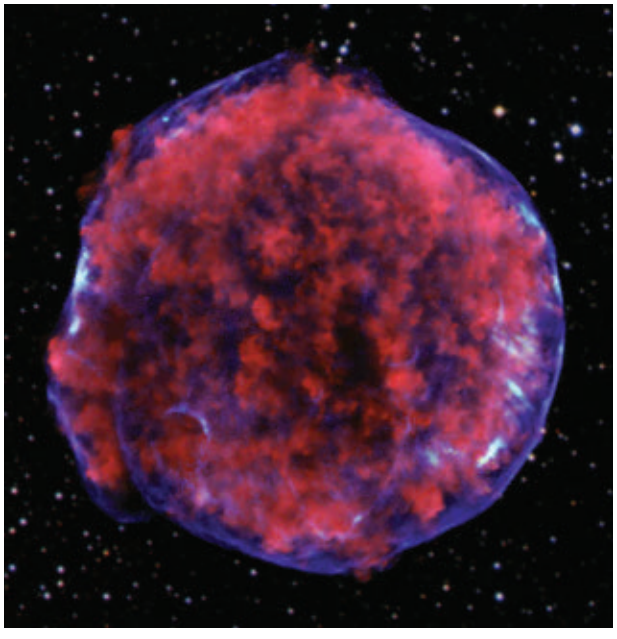
"It looks like very good and careful work," says Eric Rubenstein, president of the technology company Image Insight, who developed the hot Jupiter hypothesis while at Yale University in the late 1990s. Rubenstein says his basic idea still holds if the stellar companion isn't a hot Jupiter. "What's important is that the companion, whatever it is, interacts with the stellar magnetic field," he says. Any size will do.



This illustration shows what a superflare (white blob) might look like if seen from a planet orbiting a nearby sunlike star. The black regions are starspots.

Superflares involve a tangled magnetic linkage between star and planet — a tie that becomes twisted and stressed to the breaking point as the planet orbits. Eventually, the tie snaps like a busted rubber band, producing a violent eruption.

A superflare from the sun would cripple orbiting satellites, and power grids on Earth would be disrupted as well, Schaefer says. But the sun is unlikely to blow such enormous chunks of energy toward Earth.



Two paths to a supernova

There are two ways to light a cosmic candle. One merges two white dwarf stars; the other pairs a white dwarf with a larger stellar companion. Both combinations produce type 1a blasts like the Tycho supernova (shown), stellar explosions that act as "standard candles" for gauging astronomical distances. Type 1a supernovas are triggered when white dwarfs gain weight, igniting a thermonuclear reaction that produces a fireball of predictable brightness. Astronomers have long disagreed over what ingredients were needed to make the white dwarf go boom. Now, an international team of astronomers studying 23 recent type 1a fireballs reports that there are two viable recipes: the same ones astronomers have been arguing over for years. In both, the doomed dwarf leeches material from a companion — either a second dwarf, producing a supernova with no surrounding gas, or a larger star, generating a more powerful explosion and a gas cloud, the team will report in the *Astrophysical Journal*. Understanding precisely how these type 1a explosions are generated will help refine cosmic distance measures. — *Nadia Drake*

FROM TOP: H. MAEHARA/KYOTO UNIV.; NASA, CXC, RUTGERS, K. ERIKSEN *ET AL.*, DSS

"We're talking about this structure around our own star. And yet we … have not had a very clear idea of what was going on." —SETH REDFIELD

Sun's shock wave goes missing

Observations redraw picture of the local stellar environment

By Nadia Drake

The sun isn't quite the speed demon scientists suspected. It chugs through the galaxy at a relatively pokey 83,500 kilometers per hour — roughly 11,000 km/h slower than expected, says a report online May 10 in *Science*.

While that might not sound like a big deal, the sun's slower pace clashes with theories describing the solar system's local environment — a protective, sun-blown bubble called the heliosphere. The sun's speed helps shape the size and boundary of this elastic bubble, along with the influence of interstellar dust and gas clouds it moves through.

Scientists thought a shock wave, or bow shock, preceded the bubble's journey. But the slower sun isn't moving fast enough to create a bow shock. "We've spent the last quarter-century assuming there was a bow shock," says study coauthor David McComas of the Southwest Research Institute in San Antonio.

Though the ramifications of a missing bow shock are still unknown, scientists can now study more precisely how the heliosphere responds to the sun's travels through interstellar voids and clouds.

"We're talking about this structure around our own star," says Seth Redfield, an astronomer at Wesleyan University in Middletown, Conn. "And yet we still, up until now, have not had a very clear idea of what was going on out there."

McComas and colleagues clocked the solar system's speed using helium atoms captured by NASA's IBEX spacecraft. With no electrical charge, helium atoms can travel through magnetic fields and easily cross the turbulent boundary, called the heliopause, between the heliosphere and the local gas cloud. Thousands of helium atoms revealed the sun's speed.

The scientists also found that the magnetic field in the surrounding cloud was stronger than expected, requiring even faster speeds to generate a shock wave.

At least for now. When the sun plows into a different cloud, that might change.

"The protective shield of the heliosphere has to have changed over the lifetime of the sun," Redfield says. In 2008, he and Jeffrey Linsky studied the movement and starlight from 157 nearby stars and came up with a solar velocity very close to what McComas found. "When they matched, I was extremely excited," says Redfield, who is now studying similar bubbles around other stars.

Life

For more Life stories, visit **www.sciencenews.org**

Chimp culture in wood and stone

Groups don't all use same strategy for cracking nuts

By Susan Milius

With the discovery of notably different dining habits among neighboring groups of chimpanzees, researchers may have some of their clearest examples yet of cultural traditions among animals.

One chimp group in the Taï National Park in western Africa uses mostly rocks to hammer open the *Coula* nuts that are a seasonal staple of their diet, reports primatologist Lydia Luncz of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. Chimps living just to the east start the *Coula* season hammering with rocks but shift to easier-to-find chunks of wood as nuts lying on the ground soften and become easier to crack.

So does a third group of chimps living several kilometers to the northwest. Living as the chimps do in such close quarters, neither genetics nor ecology is likely to influence their traditions, Luncz and her colleagues argue in the May 22 *Current Biology*. These nutcracking quirks offer a tidy case study of an animal version of cultural differences.

Favoring rock nutcrackers isn't culture in the sense of human music or literature or family customs. Yet biologists scrutinize behavioral differences in nonhuman species to elucidate the evolutionary roots of humankind's capacity to learn and pass along traditions.

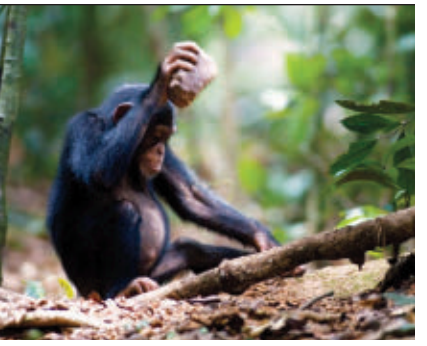
For chimp cross-cultural studies, researchers usually compare populations that couldn't share genes or even catch glimpses of each other's practices, says William C. McGrew of the University of Cambridge in England. What's newsworthy about the new work, McGrew says, is that Luncz and colleagues "systematically and quantitatively compare three groups from the same local population."

The proximity of different traditions also raises the unexpected possibility that chimps moving into a group switch their old ways to the local nutcracking style, says Carel van Schaik of the University of Zurich's Anthropological Institute and Museum. Female chimps immigrate into their adult community, and if they switch styles, van Schaik says, "we are dealing with individuals that modified something they already knew how to do."

Luncz and colleagues documented 45 chimps at work. The scientists watched as three groups of chimps ambled through their territories, spending hours banging hard-shelled *Coula edulis* nuts up to 30 times before getting the nutmeat inside.

Rocks are more difficult to find in the forest, the researchers concluded after sampling the various chimp territories. Yet early in the season, when the nuts are harder to crack, most of the chimps took the time to find a good rock.

As the nuts softened later in the season, chimps in the northern and eastern groups shifted toward easier-to-find wood for nutcracking. Wood itself sometimes cracked, requiring that a chimp look around for a new hammer.



A juvenile chimpanzee in western Africa cracks nuts with a rock. Some chimp groups use stone tools exclusively; others sometimes use wood tools.

Animal behaviorist Bennett Galef of McMaster University in Hamilton, Canada, says he'd like to know how the chimp quirks spread and how the process resembles the spread of human culture.

Bats skillfully avoid poisonous prey

Fringe-lipped bats eat frogs even though gulping the wrong one in the dark could be fatal. New high-speed video shows that the tropical bats deploy a sequence of senses to update their judgment of prey and avoid eating a toxic amphibian, Rachel Page of the Smithsonian Tropical Research Institute in Gamboa, Panama, and colleagues report in an upcoming *Naturwissenschaften*. Various bats will nab frogs, but only the fringe-lipped *Trachops cirrhosus* (shown) is known to follow frog calls. Fringe-lipped bats turned aside in mid-air when the researchers broadcast the enticing "tuuun chuck" call of the túngara frog (shown) but offered up a cane toad, too big for a bat to carry off. Tests also revealed that playing túngara calls while offering a right-sized but toxic leaf litter toad led bats to catch and then drop the unpleasant prey. —*Susan Milius*

FROM TOP: MARK LINFIELD; CHRISTIAN ZIEGLER

ONLY 1,500 AVAILABLE

It's a first. It's silver. It's patriotic. And it's a steal.

Washington crossing the Delaware. Eisenhower launching D-Day. Kennedy rescuing the crew of PT 109.

These men made history.

This set made history

To celebrate the bicentennial of America, the U.S. Mint struck this special three-piece proof set honoring these three American presidents—and our 200th birthday. To capture the bicentennial spirit, the coins in the set are dual–dated 1776–1976.

This set was so popular over 4 million were sold.

Unlike the regular circulating coins of the day, the coins in this set are struck in precious silver.

It's the first commemorative U.S. Mint Proof Set *ever*. It's also the first proof set to feature all dual-dated coins. And finally, it's the first U.S. Proof Set to include a Silver Dollar. Americans love proof coins from the U.S. Mint. Each is struck twice from specially prepared dies and has deeply-mirrored surfaces and superb frosty images.

And you know you've got a *real piece of American history* when you hold this set—the red white and blue holder is spectacular!

Now for the steal part...

This first-ever Bicentennial Silver Proof Set sold out at the mint three decades ago. When you consider how much prices have risen since then, you might expect to pay $100 *or more* to buy this set today.

But for this special offer, we are releasing our entire stock of Bicentennial Silver Proof Sets for only $49 each. *Or better yet, buy five and pay only $39 each!*

Order now risk free

We expect our small quantity of Bicentennial Silver Proof Sets to disappear quickly at this special price. We urge you to call now to get yours. You must be satisfied with your set or return it within 30 days of receipt for a prompt refund (less s&h).

Buy more and SAVE

1776-1976 Bicentennial Silver Proof Set
$49 + *s/h*

5 for only $39 each + *s/h*
SAVE $50

Toll-Free 24 hours a day
1-800-558-6468

Offer Code BPF191-02
Please mention this code when you call.

GovMint.com
YOUR ONE BEST SOURCE FOR COINS WORLDWIDE

14101 Southcross Drive W.
Dept. BPF191-02
Burnsville, Minnesota 55337
www.GovMint.com

Prices and availability subject to change without notice. Past performance is not a predictor of future performance.
Note: GovMint.com is a private distributor of worldwide government coin issues and is not affiliated with the United States government.
Facts and figures were deemed accurate as of March 2012. ©GovMint.com, 2012

BBB ACCREDITED BUSINESS

ADVERTISEMENT

Feel the BURN

Most of the fat found in adults is white fat (top). But a small amount of brown fat (bottom), once thought obsolete, could be harnessed to burn energy.

Turning on brown fat in humans may boost weight loss

By Tina Hesman Saey

Bruce Spiegelman isn't always happy with the way his research gets portrayed. He and colleagues discovered a hormone that muscles make during exercise. When given to mice, the hormone causes the animals to burn more energy and lose weight, and improves their response to insulin — all without changing how much the mice eat or exercise. The press touted the discovery as "exercise in a pill."

"I really hate that," says Spiegelman, a cell biologist at the Dana-Farber Cancer Institute and Harvard Medical School in Boston. "The goal is not to put exercise in a pill."

His goal, instead, is to harness a special type of fat, called brown fat for its color, to replicate the metabolic benefits that exercise delivers. While some researchers have dismissed this fat as a mostly obsolete relic that makes little if any contribution to people's energy expenditure, new research shows that it can make humans feel the energy burn. Some scientists have found chemical secrets for activating brown fat already in the body, while others are learning how to turn energy-storing white fat brown.

Together, such efforts may help fight the battle of the bulge, reducing obesity and the diseases that go along with it. Turning brown fat on may also benefit people who cannot exercise because of disabilities.

Fired up

For many years scientists have recognized brown fat as an energy-burning powerhouse that helps animals and human babies stay warm. But general wisdom held that the brown fat pads on babies' backs melt away during childhood, leaving adult humans with only white fat. Then three independent studies published in the *New England Journal of Medicine* in 2009 revealed that adult humans do have deposits of brown fat, especially around the neck and collarbone (*SN: 5/9/09, p. 10*). Some studies suggested that brown fat could become active in the cold, but no one knew how well it would work.

André Carpentier of the University of Sherbrooke in Canada counted himself among the doubters of brown fat's energy-consuming potential. Even if the little brown fat depots in the neck turn on, "I was skeptical that it was enough to burn a lot of energy," he says.

To find out what brown fat really could do, Carpentier and his colleagues asked six healthy men to put on bodysuits that can be used to regulate body temperature. The researchers pumped cold water through the suits so that the temperature of the men's skin dipped by about 3.8 degrees Celsius — just enough to get brown fat active, but not so much that muscles would generate heat by shivering. Shivering would have meant muscles were burning energy, and the researchers wanted to make sure the energy consumption, tracked via full-body PET scans, came from fat alone.

All of the men burned more energy in the cold suits than at room temperature, but the degree to which brown fat kicked in varied, the researchers reported earlier this year in the *Journal of Clinical Investigation*. On average, the men burned 250 extra food calories during three hours in the cold. Cutting that many calories from the diet on a daily basis would add up to about half a pound of weight loss per week.

The researchers measured noticeable increases in the amount of energy that brown fat consumed in the form of glucose and noted that the brown fat's volume shrank. The brown fat "was actually burning its own fat," Carpentier says. Studies in mice have shown that brown fat will burn through lipids contained

BOTH: BIOPHOTO ASSOCIATES/PHOTO RESEARCHERS, INC.

within its own cells as well as lipids in white fat cells.

When brown fat was activated, the men's metabolic rate was 1.8 times the rate at rest. The study is the first to demonstrate that brown fat contributes to adult human metabolism.

"But you nevertheless have to keep things in perspective," Carpentier says. Walking raises the metabolic rate to about two to three times the rate at rest, and running cranks it up to 10 times the resting rate. "I don't think we're going to solve the obesity and diabetes problem just by activating brown fat," he says. But stimulating the fat could supplement other obesity-fighting measures.

Burn boosters

Previous studies have indicated that brown fat is harder to find in obese people and diabetics than in lean or healthy people. That's probably because the brown fat in obese people is immature and doesn't have the energy-burning capacity that typically makes the fat easy to spot on scans, says Devanjan Sikder, a neurobiologist at Sanford-Burnham Medical Research Institute in Orlando, Fla.

Sikder and colleagues reported last year in *Cell Metabolism* that a brain chemical called orexin helps brown fat mature. Orexin, also called hypocretin, is famous for stimulating appetite and keeping people awake. Sikder's team plans to start a clinical trial to test orexin's ability to get brown fat going in humans.

Firing up brown fat may just take a little muscle. Getting the heart pumping is one way to generate natural substances that stimulate brown fat, Sheila Collins of Sanford-Burnham and her colleagues recently found.

During exercise, the heart releases molecules called natriuretic peptides, which help lower blood pressure by signaling the kidneys to dump fluids. Those same hormones help feed energy to the heart by turning on brown fat, Collins and colleagues reported this year in the *Journal of Clinical Investigation*. The heart hormones caused both white and brown fat cells from mice and humans to produce more of some proteins that stoke brown fat's fires. Such heart hormones might trick the body into thinking it is in a cold environment and should throw another log on these fires.

1.8
Factor by which brown fat boosted metabolism in a recent study

10
Factor by which running boosts metabolism

Although the body naturally makes some brown fat–boosting substances, including two more possibilities reported recently in *Cell Metabolism*, it's not clear what the long-term consequences of extra doses might be. Since natriuretic peptides also help regulate blood pressure, one possible consequence of the hormones identified by Collins' team might be low blood pressure. But Collins says that a little bit might be enough to rev up brown fat without causing unwanted side effects.

"I don't think it takes a huge amount of these peptides to have a beneficial effect over time," she says.

The heart isn't the only muscle with the power to kick-start metabolism. During exercise, skeletal muscles release a hormone called irisin, Spiegelman and colleagues reported in *Nature* in January. It's irisin that some have christened "exercise in a pill."

Irisin doesn't seem to turn on brown fat deposits in the neck, though. Instead it encourages brown fat–like cells within white fat to get going, essentially turning white fat brown. Spiegelman's group has dubbed these brownlike cells "beige" cells.

No one knows how many beige cells can exist within white fat, so it's difficult to predict just how much energy might be burned by stimulating the cells. Also unknown is whether obese people have fewer of the cells than normal-weight people.

Stoking brown fat does have the potential to aid in weight loss and help fend off diabetes. But Spiegelman dismisses the idea that the average couch potato could take a pill and get the benefits of exercise without ever jogging a step or lifting anything heavier than the remote control. Burning more energy, he notes, isn't the only benefit of exercise. Even turning brown fat up to the max probably won't improve bone strength or increase lung capacity or do many of the other things exercise is good for.

Still, for people who cannot exercise — such as those paralyzed by accidents or disease — irisin and other brown fat stimulants may be the next best option. They could possibly confer another perk of exercise, too: strengthening neural-muscular connections.

Spiegelman hopes the molecules will help people with amyotrophic lateral sclerosis hold onto nerve connections or even build new ones, possibly delaying or reversing the disease. "That's a bit of a dream," he says, "but why not dream?" ■

In a recent study, men in cold suits burned more energy than they did at room temperature. PET scans allowed researchers to track brown fat's energy use.

A. CARPENTIER, F. HAMAN, E.E. TURCOTTE

Explore more

- Guide to the benefits of exercise: www.cdc.gov/physicalactivity/everyone/health

At home IN THE UNIVERSE

Astronomers lay bare the Milky Way's biggest secrets

By Alexandra Witze

When Lewis and Clark started exploring the West, they didn't know much about what lay beyond St. Louis. Neither, at first, did astronomers know much about cosmic realms beyond Uranus.

But just as 19th century explorers filled in huge blanks on the American map, so did 20th century skywatchers flesh out a much greater map — of frontiers far beyond the solar system, out across the entire Milky Way. Now, in the last few years, cosmic cartography has again redrawn modern science's picture of the galaxy, from the inside out.

Surprising new findings from this endeavor begin at the Milky Way's heart, where astronomers recently spotted a tendril of gas streaming toward the galaxy's central black hole. Next year, scientists will have a ringside seat for the first time as the matter swings perilously close to its doom.

Farther out from this voracious maw, astronomers have looked at the Milky Way's central clump of stars and found that much of it rotates not only with the pinwheel shape of the galaxy, but also in a different direction. And in the widest possible view, attained by peering at radio waves emanating from the far side of the galaxy, researchers have started to map out the full symmetry of the Milky Way — including the startling discovery of spiral arms that had long lain unseen.

Studying the galaxy illuminates more than just this corner of the cosmos. It also helps astronomers better understand the origin and fate of other galaxies, such as nearly two dozen small ones that dance alongside the Milky Way and billions of other spiral galaxies throughout the universe.

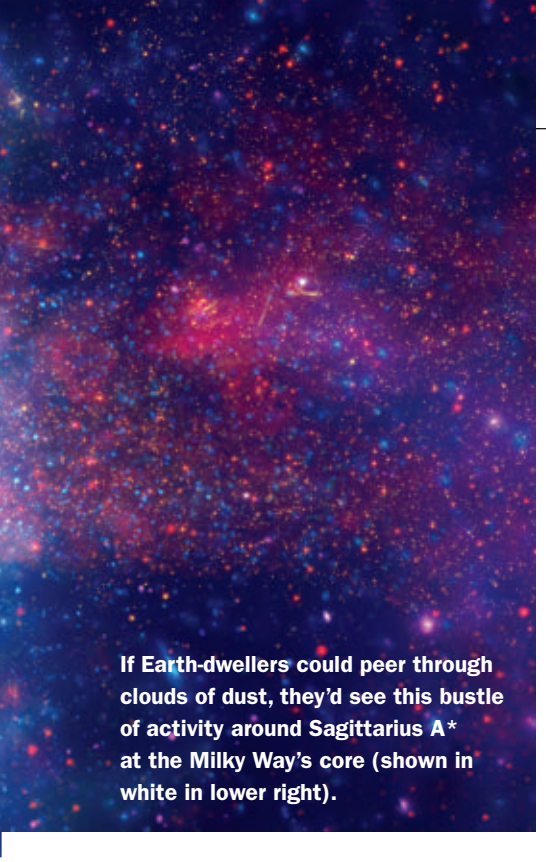
The newest galactic explorations may even reveal the solar system's ultimate end. The Andromeda galaxy, which is zooming this way, is expected to smash into the Milky Way some 3 billion years from now. Just how massive the Milky Way is — a crucial statistic currently being updated — will determine how the cosmic collision plays out.

Milky Way metropolis

In many ways, it's easier to study a galaxy millions of light-years away than to probe this one. Astronomers must infer what the Milky Way looks like from the outside while embedded deep within it, and huge dust clouds obscure much of the view. As a result, "we know galaxies across the universe much better than we know the Milky Way," says Mark Reid, an astronomer at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass.

Early scientists were convinced that the Earth lay near the center of the galaxy; the first map of the Milky Way, compiled by British astronomers William and Caroline Herschel in 1785, showed the solar system drifting in what looked like a starry puddle. But the Herschels generated that map by counting stars, a method

X-RAY: NASA, CXC, UMASS, D. WANG *ET AL*; OPTICAL: NASA, ESA, STSCI, D. WANG *ET AL*; IR: NASA, JPL-CALTECH, SSC, S. STOLOVY



If Earth-dwellers could peer through clouds of dust, they'd see this bustle of activity around Sagittarius A* at the Milky Way's core (shown in white in lower right).

that doesn't include the all-important gas, dust and other free-floating stuff. By 1920, American astronomer Harlow Shapley had looked instead at star clusters orbiting the Milky Way and figured out that the solar system is perched off to the side. Today astronomers know that the sun is 27,000 light-years away from the galactic center, requiring about 230 million years to complete an orbit around it.

At the center lurks the Milky Way's central black hole, also known as Sagittarius A* (pronounced "A-star") because it lies in the constellation Sagittarius. Most galaxies have such a central black hole around which stars, gas and dust swirl as if going down a drain. Sagittarius A* is a heavyweight among black holes, coming in at around 4 million times the mass of the sun (although it is only about 15 times as wide). The black hole's massive gravitational pull makes it a sort of Grand Central Station, where stars, gas and dust assemble in an urban galactic buzz.

Because the black hole itself is, well, black, astronomers had to deduce its existence by carefully measuring the paths of stars circling it. Two teams — one in California, the other in Germany — have been doing this for nearly two decades and still have plenty to learn.

In 2018, for instance, a star known as S02 will make its closest approach to Sagittarius A* in about 16 years, zooming by at just three times the average distance between Pluto and the sun. By tracking how the star swings past the black hole like a passenger train, scientists can test Einstein's theory of general relativity, which makes specific predictions about how matter should behave so close to a gravitational sink. "This would be a test on the largest mass scale that's ever been done," says Andrea Ghez of UCLA, leader of the California group.

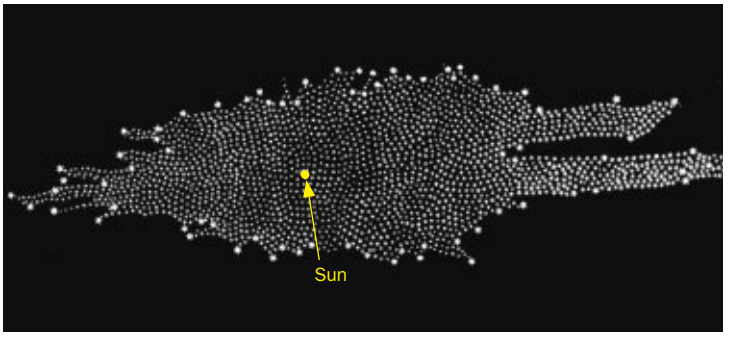
New upgrades to existing telescopes should give astronomers a far better view than the last time S02 swung past, in 2002. Some of the world's biggest facilities, such as the Very Large Telescope and Gemini telescopes in Chile, are installing a new generation of adaptive optics, shining multiple lasers into the sky as guides so that technicians can measure and correct for the distorting effects of Earth's atmosphere. This summer, Ghez will help lead a worldwide push to observe the galactic center. Eventually she aims to expand her study of stars from the current maximum of around 0.3 light-years away from Sagittarius A* to those that sit around three light-years away.

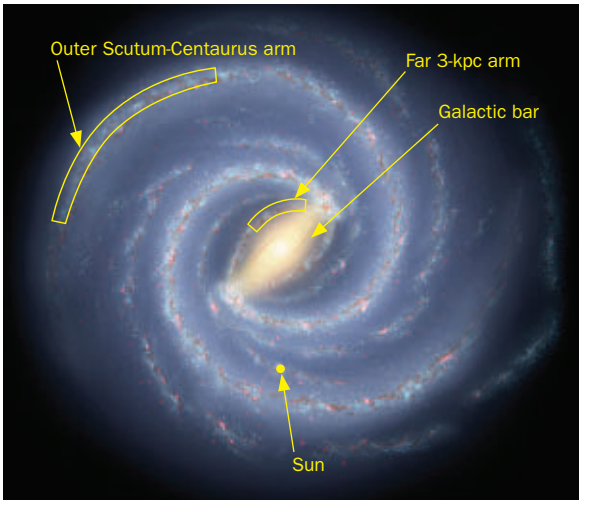
She also wants to track stars that weigh less than the current observing limit, around eight times the sun's mass, to see if lighter stars behave differently. "There's so much excitement, which is why we keep going," Ghez says. "You can make predictions about what kind of stars exist near a black hole, which tells you about how black holes and galaxies form and evolve over time."

Stars aren't the only things careening around the hub of Sagittarius A*. So too is a gas cloud on its death march, described in *Nature* in January by the German-led research team. Using the Very Large Telescope, the scientists took pictures of this blob — only about three times the mass of the Earth — speeding up from 1,200 kilometers per second in 2004 to 2,350 km/s in 2011. Already it is stretching out, like a strand of spaghetti headed directly for Sagittarius A*.

By the middle of next year, the cloud should make its closest sweep by the black hole, at a distance of around 40 billion kilometers, says Stefan Gillessen

A galactic map created by William and Caroline Herschel in the late 18th century shows the sun close to the center of a puddle of stars (below). Today maps of the Milky Way put the sun off to the side of a central bar (right). The symmetry of this map has recently been enhanced with the discovery of two new arms (outlined in yellow).





TODAY'S GALAXY: NASA, JPL-CALTECH

of the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. Part of the cloud may even fall into the black hole, which would burp extra X-rays as it digests its meal. "It's absolutely wonderful that we can watch this in real time," Gillessen says. "We really don't know what may happen."

Not all astronomers are convinced the blob is really a gas cloud or that it is destined to fall into Sagittarius A*. Ghez sees the object in her data but thinks it might be a fast-moving star on an everyday path around the black hole. And others have proposed the cloud could instead be chunks of debris, such as the shattered remains of a planet-forming disk that could continually feed Sagittarius A*.

Bar of the stars

If the urban core of the Milky Way is Sagittarius A*, then suburbia is the galaxy's bulge — the sphere-shaped blob of stars in its middle. If you could look at the Milky Way edge-on, like a phonograph record from the side, you'd see that the bulge extends both above and below the galactic plane like an orange at the record's center — an orange about 8,000 light-years across.

How and why the bulge formed is still something of a mystery. Most theories suggest that it came together soon after the Milky Way was born 12 billion to 13 billion years ago. In this scenario, no more than a billion years passed between the huge starry disk coalescing and its center building up and bulging out from the main galactic plane.

But new studies of some bulge stars suggest they are much younger than expected — on the order of only 2 billion to 5 billion years, says Michael Rich, a UCLA astronomer who led a survey of 10,000 stars. So astronomers need to figure out whether those youthful stars are simply a few newcomers on the block, or whether they indicate a bigger problem for the standard ideas about when the entire subdivision was built.

Suburbia wouldn't be complete without a neighborhood bar, and the galactic bulge is no exception. Running right through the bulge is a dense elongated concentration of stars, as if someone had rammed a thick straw into the orange along the plane of the phonograph record. This tubelike clump of stars is known as the bar. From either end of it, great streams of stars pour off to form the iconic pinwheel shape of the Milky Way.

Rich's survey uncovered a curious feature of how the bar rotates: cylindrically, like a toilet roll holder, even as it spins with the pinwheel of the rest of the galaxy. This cylindrical rotation has been seen in other galaxies and could be common throughout the universe, the team wrote in March in the *Astronomical Journal*.

But because the bulge and its bar are buried in dust, astronomers have a tough time seeing what's going on. Many can't even agree on where the bar leaves off and the bulge begins. "It's just a mess right now," says Robert Benjamin, an astronomer at the University of Wisconsin–Whitewater.

One new theory might help with the cleanup. A team led by Juntai Shen of the Shanghai Astronomical Observatory in China has been running computer simulations of how the bulge might have formed, based on data from Rich's Bulge Radial Velocity Assay survey. The findings go against a leading theory holding that the proto–Milky Way must have collided with other disks of stars and that the bulge was created when all those pieces merged together. Rather, Shen's team suggests that the spinning disk of the protogalaxy could have naturally generated a handlelike bar that then thickened on its own.

The model provides a straightforward explanation for how the bulge and bar could have come to be, Rich says.

Outstretched arms

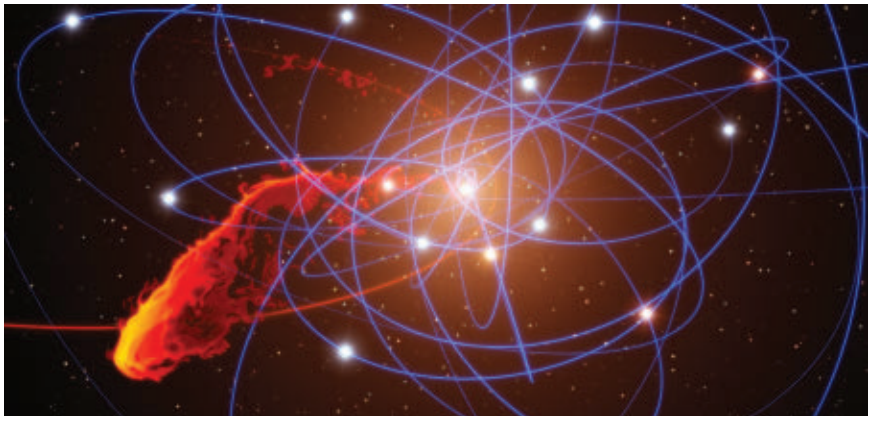
Galaxies with bars are more likely to have spiral arms tracing a beautiful symmetry into the outer reaches, as the Milky Way does. New explorations of these rural landscapes map out how these stars form a far-flung pinwheel about 100,000 light-years across.

Putting together the full picture isn't easy. "Galactic astronomy is like a giant jigsaw puzzle where the pieces are coming in in the wrong order," Benjamin says.

The first jigsaw piece fell into place in the 1950s, when astronomers discovered that they could study a particular spectral line in light coming from distant stars to trace how neutral hydrogen gas is distributed through the spiral arms. This particular wavelength, at 21 centimeters, is in the radio part of the electromagnetic spectrum, which means it can pass unscathed through the dust that blocks telescopes' view in visible wavelengths. Suddenly, scientists could look for signals coming from gas clouds in other parts of the galaxy and begin to map out its large-scale structure.

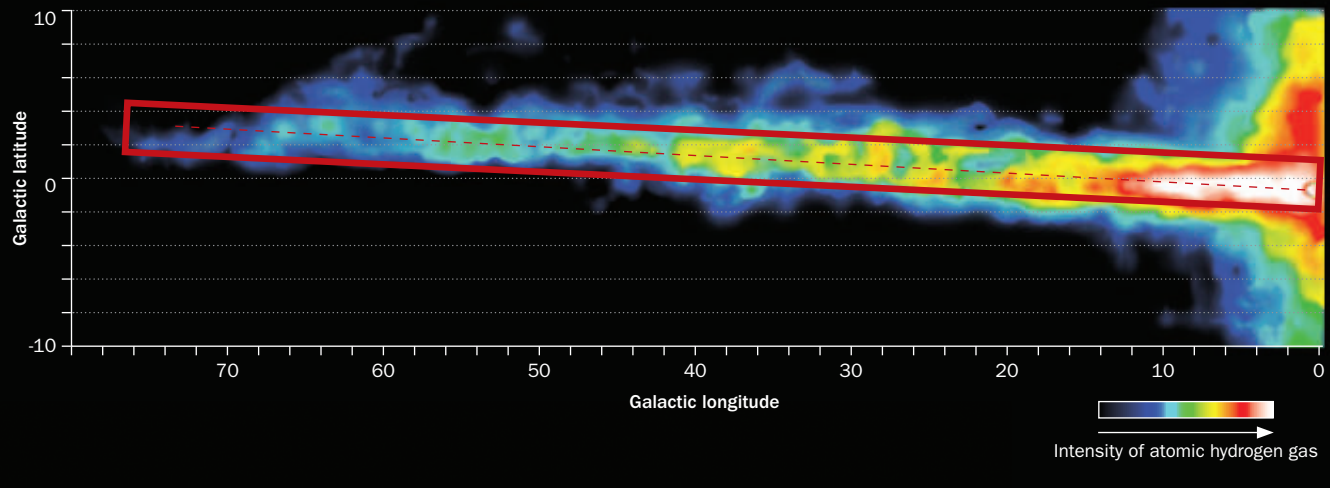
Yet after those initial maps, understanding galactic structure essentially

Gassy tendril A cloud of gas is thought to be streaming toward the Milky Way's central black hole, destined to one day break apart. The image below simulates what the remnants of the cloud (orange and yellow, orbit in red) and its surrounding stars (blue orbits) may look like in 2021.



ESO, MARC SCHARTMANN/MPE

Galactic extension When viewed in wavelengths corresponding to atomic hydrogen gas, the newfound Outer Scutum-Centaurus arm of the Milky Way appears as a tilted band. Astronomers hadn't spotted the arm until recently because this part of the galactic disk is warped with respect to the middle of the galaxy, like a phonograph record bent by the heat of the sun.



T.M. DAME AND P. THADDEUS/HARVARD-SMITHSONIAN CENTER FOR ASTROPHYSICS, ADAPTED BY STEPHEN EGTS

stalled as scientists faced problem after problem, such as distinguishing whether a particular cloud was on the Earth's side or the other side of the galactic center. Only in the last decade have astronomers been able to use other data, such as how other kinds of gas clouds are distributed, to get around such issues.

In 2008, for instance, Thomas Dame and Patrick Thaddeus of the Harvard-Smithsonian Center reported finding a curving spiral arm on the far side of the galactic center. The arm, now called Far 3-kpc, is a counterpoint to a similar arm on Earth's side. And last July, the team reported discovering one of the most distant spiral arm features yet known — the continuation of an arm called Scutum-Centaurus that wraps around this side of the galaxy, disappears on the other side and finally pops out again where it was spotted (*SN: 6/18/11, p. 14*).

Nobody had seen the arm segment before because the galactic disk turns out to be slightly warped in the outer reaches, like a Frisbee left too long in the sun. The team stumbled upon it by looking for carbon monoxide as well as atomic hydrogen gas. "It occurred to me when I first saw it that it could be the outer arm," Dame says. "Then I said: 'This can't be.'"

Dame and other scientists are now trying to link the outer part of the arm to the inner part, like a game of celestial connect-the-dots. Dame readily admits the arm may not trace back to where he and his colleagues think it should; the galaxy may still hold surprises. To date, the best scientific summary of the Milky Way's structure is not a scholarly publication but a picture: an artist's conception of the galaxy as seen from above, in a beautiful mirror-image spiral. "The chances are very significant that the Milky Way is not as orderly as that model shows it," Dame says.

Answers may soon come from a massive survey to map out galactic structure using cosmic masers, which amplify astronomical emissions like a laser. The Bessel Survey, co-led by Reid, is in the middle of five years of precisely measuring distances to roughly 400 masers throughout the galaxy, including looking through the galactic center and out on the other side into the distant reaches.

Already, the survey has turned up some shockers, such as revising official estimates for how far the sun is from the galactic center and how fast the galaxy is rotating. Bessel results have nudged the solar system closer to Sagittarius A*, from the old estimate of 27,700 light-years to 27,400 light-years, and sped up the galaxy's rotation speed from 220 km/s to about 250 km/s.

That faster spin means that the Milky Way must be about 50 percent more massive than previously thought, Reid and colleagues reported in 2009 in the *Astrophysical Journal*. If so, then the Milky Way is no longer just the Andromeda galaxy's little sibling, as scientists had long thought, but each galaxy weighs about the same amount. The mutual gravitational pull of the Milky Way and Andromeda are ushering the pair closer together, and the added Milky Way heft may speed up their collision a little (*SN: 1/31/09, p. 8*).

Even better maps of the entire Milky Way may come starting next year, when the European Space Agency plans to launch Gaia, a spacecraft designed to measure the locations of 1 billion (yes, billion) stars above and below the galactic plane. That's about 1 percent of all the stars in the galaxy, charted with extreme precision. If it succeeds, Gaia will take galactic exploration far from its Lewis and Clark days and well into its space-odyssey future.

"We now have all of these different ways to map the galaxy," Benjamin says. "It's a question people sort of forgot was interesting, partly because the field had been so problematic for so many years. Now people are looking at data afresh and finding new things. We may run aground again. But we'll see how the rest of it fills in." ■

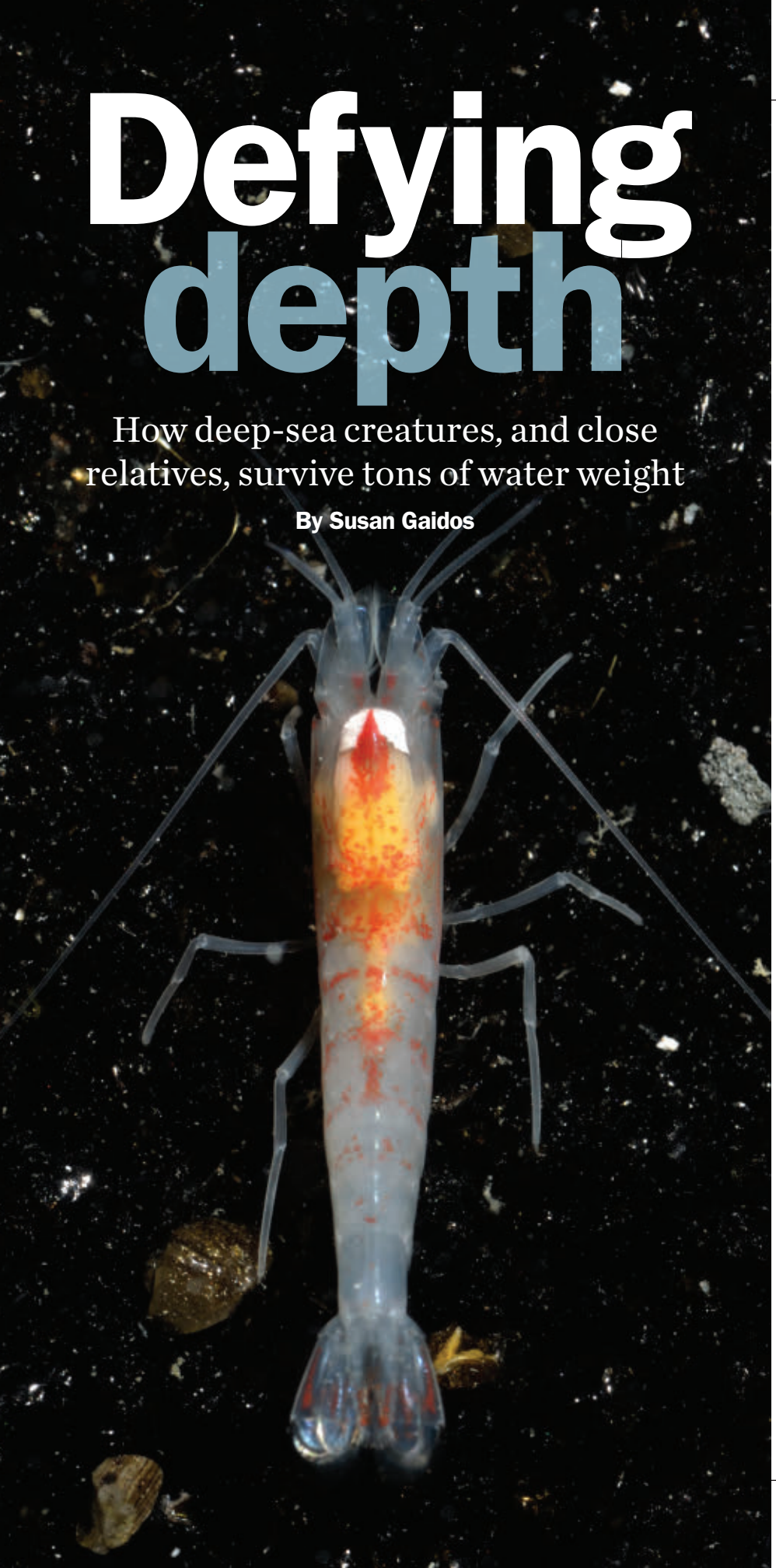
Explore more

■ ESA's Gaia mission: bit.ly/6D1t4

Defying depth

How deep-sea creatures, and close relatives, survive tons of water weight

By Susan Gaidos



When you think about life's pressures weighing down on you, consider the plight of *Palaemonetes varians* — the Atlantic ditch shrimp.

Smaller than a finger, and covered with only a thin shell, the translucent creature flourishes in the warm, shallow waters off the coast of northern Europe. Recently, though, scientists at the University of Southampton in England have plucked dozens of the critters from their homes and carried them to the lab, placing them in reinforced containers that replicate the crushing pressures found more than three kilometers beneath the sea's surface. Here, where the strain of the water can squash a human's rib cage, the shrimps survive quite happily. When the pressure's on, this animal can sink *and* swim.

Scientists are subjecting the shrimps to these extreme conditions to better understand the mechanisms that allow some marine animals to adjust to life in the deep sea. Other teams are traveling to the deepest parts of the ocean — where pressure can reach more than 16,000 pounds per square inch — to study the biology of creatures that already thrive when tremendous weight bears down on them.

Exactly how deep-sea animals withstand intense pressures is not completely known, even though scientists have puzzled over this question for decades. For a long time researchers have relied on tissue samples taken from animals pulled up in nets. By comparing related proteins in shallow-water and deep-water species, researchers have found that extreme pressure can inhibit the activity of some proteins. Other studies have shown that small molecules called piezolytes may help protect proteins from the pressure.

While there is still much to be learned from tissues, the ability to bring live

By subjecting the Atlantic ditch shrimp (facing page) to conditions experienced by its deep-dwelling relative *Mirocaris fortunata* (left), scientists hope to get a better idea of how animals handle pressure.

© OCEANOPOLIS

animals up from the deep, while maintaining their natural pressure along the way, is allowing scientists to look beyond individual molecules and study whole-body reactions. New tools designed to keep creatures alive at the surface for months will help researchers document a host of changes in the animals over time.

The work may help scientists piece together a more complete picture of how life in the ocean's high-pressure zone survives, and how it got there in the first place, says Sven Thatje, an evolutionary ecologist at Southampton. He presented findings from his shrimp studies in Vancouver earlier this year at a meeting of the American Association for the Advancement of Science.

Evolutionary scientists believe that climate shifts at various times during Earth's history wiped out many of the animals living in the deep sea. These extinctions were probably followed by recolonization of the dark depths by shallow-water species, which somehow were able to adapt.

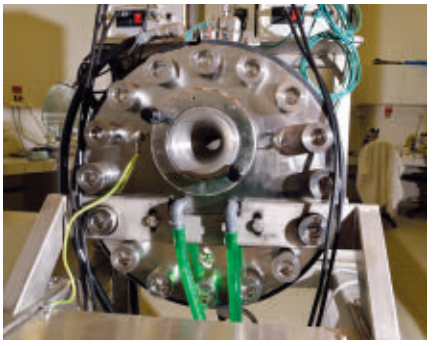
Understanding how creatures could make such a remarkable transition not only sheds light on the basic biology of living under pressure, but may also provide clues to how sea life will respond to new conditions brought by global warming.

"Going to greater depths might allow some species to escape undesirably warm surface waters," Thatje says.

But greater depths come with much more water weight.

A deep menagerie

Living under high pressures is actually quite common. The deep sea — defined as any part of the ocean more than 200 meters below the surface — makes up about two-thirds of the inhabited biosphere. Here, the dark, frigid waters come with pressures intense enough to mash a Styrofoam cup to the size of a thimble. For years, though, this harsh environment was left largely unexplored.



The Abyss Box, designed to house ocean dwellers at high pressures on land, weighs more than half a metric ton. The viewing window is about 10 centimeters thick.

But in the last half century, advances in deep-sea submersibles and technologies designed to peer into the darkness have allowed researchers to observe and uncover many mysteries of the deep ocean realm. Instead of finding a barren landscape, these explorers have discovered scores of strange-looking animals living in even stranger conditions.

In 1977, scientists stumbled for the first time on communities clustered near hydrothermal vents, roughly 2,500 meters down on the seafloor near the Galápagos Islands. The vents spew superheated, chemical-rich fluids that sustain animals such as giant clams, mussels, tube worms, snails and shrimps. Other researchers, exploring even greater depths, have found a diversity of invertebrates including shrimplike amphipods and sea cucumbers, as well as unusual fish such as the angler.

Still, the number of animal species in the sea drops the deeper you go. Fish, for example, are seldom seen below 8,000 meters, possibly because of high pressures.

On the Earth's surface, humans experience what is known as one atmosphere of pressure: a mere 14.7 pounds of air per square inch. But water is denser than air. Diving below the sea, the weight of water above causes the pressure to increase about one atmosphere every 10 meters. At around the depth of the Galápagos vents, the pressure is 250 atmospheres, or more than 3,600 pounds per square inch. Bruce Shillito, a biophysicist at the Université Pierre et Marie Curie in Paris, compares that pressure to an elephant sitting on your toenail.

Even in the early days of deep-sea exploration, scientists found themselves puzzling over the ways in which close kin of shallow-water species could thrive at much greater depths. But bringing species up for study in the lab proved difficult. Some animals have gas-filled swim bladders that explode on the way to the surface, killing the animal. Animals that lack swim bladders and make it to the surface alive often don't live long because of the huge change in pressure. So scientists had to busy themselves with tissue samples taken from creatures pulled from the water.

Some of the first clues to high-pressure adaptations came in the late 1970s. Two biochemists at the Scripps Institution of Oceanography in La Jolla, Calif., compared a common protein in shallow- and deep-water thornyhead fishes, a group related to the rockfishes found off the west coast of North America. Joseph Siebenaller, now at Louisiana State University in Baton Rouge, and George Somero of Stanford University discovered a key difference in an enzyme known as lactate dehydrogenase, or LDH, which plays a key role in the generation of energy needed to power swimming movement.

Their studies showed that LDH of the shallow-water relatives performed well only at the low pressures associated

TANKS: © OCÉANOPOLIS; SHRIMP: PIET SPAANS/WIKIMEDIA COMMONS

with depths less than about 500 meters. In contrast, the slower-working LDH of a deep-living fish continued to work well at the elevated pressures of deeper environments. Further studies found that the LDH in pairs of species across four different families exhibited similar pressure dependence.

Siebenaller also teamed up with biologist Paul Yancey of Whitman College in Walla Walla, Wash., to find another potential way in which deep-sea animals adapt: through small molecules called piezolytes that prevent pressure from distorting proteins. Yancey was studying how one such molecule called trimethylamine oxide, or TMAO, helps stabilize shark proteins against the high concentrations of urea stored in shark tissues. He figured if TMAO could help shark proteins perform with urea, it might help with pressure too.

When added to tissue samples of fish, TMAO stabilizes the proteins against the effects of high pressure, allowing them to fold into their proper three-dimensional shapes.

TMAO is also found in bony fish, crabs and shrimps. "It's what gives fish and shrimp their fishy smell," Yancey says.

Since these discoveries, scientists have found other molecules that act as protein stabilizers in deep-sea bacteria and animals. Yancey and his group have discovered an as-yet-unidentified stabilizing molecule in clams. And a pressure-related molecule found in sea cucumbers is now being tested to see if it can stabilize the proteins and perhaps prevent the malformed amyloid-beta clumps associated with Alzheimer's disease.

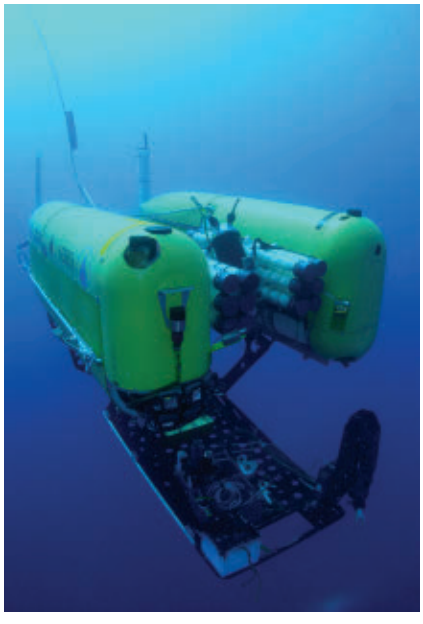
Still, questions remain about the details of protein stabilizers: Do they protect all deep-living animals or just some? And can they protect animals living in the deepest regions of the seafloor?

Traveling down

Luckily for scientists, new and improved submersibles are granting easier access to the ocean floor. Yancey has recently linked up with an international team to study tissues of animals pulled from the deepest canyons on Earth. Early next year, the group will explore the Kermadec Trench, an area located off the northeastern tip of New Zealand where parts of the seafloor dip more than 10 kilometers below the sea's surface. To reach the ocean's bottom, researchers will use an unmanned, remotely operated vehicle called Nereus, developed at Woods Hole Oceanographic Institution.

Nereus is one of the first submarines capable of operating at such crushing pressure, up to 1,000 times the pressure found at the surface, says Andrew Bowen, project manager and principal developer of Nereus at Woods Hole. Weighing nearly three metric tons and measuring more than 4 meters long, the vehicle can operate as a free-swimming robot to survey areas along the ocean floor, or work as a tethered vehicle for close-up views. A hydraulically operated, robotic arm can collect biological samples.

From these depths, Yancey says, he hopes to pull up specimens such as sea cucumbers and arthropods. Once the animals are back in his lab, he will compare their proteins with those found in shallow-water relatives and look at which stabilizing molecules the deep relatives produce and how much.



A robotic submersible called Nereus can observe and collect samples of deep-sea life at pressures 1,000 times those at the ocean's surface.

WHOI

"We want to see if, down in the trenches, the animals are making a lot more of these protein-stabilizing molecules, such as TMAO," Yancey says. Such studies could confirm that these molecules help animals tolerate bone-crushing pressures.

Pulling up

While tissue studies have offered a lot of starting information, they don't provide a firm basis for talking about the effects of pressure for a whole organism, Somero says.

"When you do work at the biochemical level, you think you're developing a story that applies to the whole living organism, but you often don't really know that," he says.

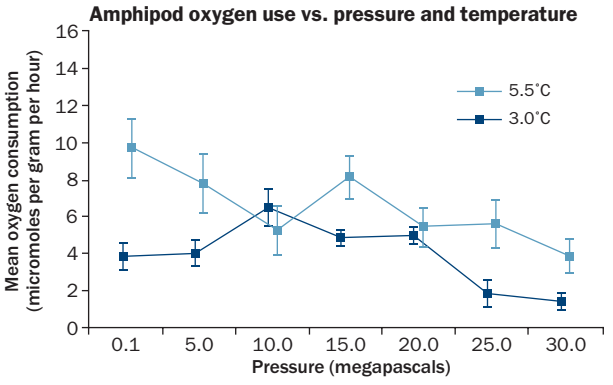
Scientists have been trying for decades to keep animals alive on their journey to the surface. Researchers have brought the creatures up slowly, hoping they will acclimate to the surface-level pressures on the way. Others have tried pulling animals to the surface quickly, then tossing them in a small pressure tank to bring them back to higher pressures. Animals that survived this trauma are placed in decompression chambers (similar to those used by divers) to see if they can adjust to shallow-water pressures for long-term study.

But such processes take a physiological toll on the animals. Somero says that over the years, only a few deep-sea organisms have been kept alive at the surface for more than a few days.

Recently, scientists have found ways to catch, recover and keep marine animals healthy at their natural pressures. Working with Gérard Hamel, an engineer at the Université Pierre et Marie Curie, Shillito developed a chamber to capture deep-sea creatures while keeping them under their natural pressure the whole way up. In the summer of 2008, the pair made headlines when they retrieved a live deep-sea fish from a record depth — more than two kilometers below the surface on vents in the Mid-Atlantic Ridge.

Now the group is testing ways to transfer its catches from the sampling device

Mixed effects
How well animals adapt to new environments may depend on a mix of factors. At higher temperatures, a shrimplike creature that normally lives near hydrothermal vents consumes more oxygen than when temperatures are lower. Oxygen consumption is used as a marker for survival success.



into a pressurized tank and take them to the lab, with no decompression in the process. Once in the lab, the animals are placed in pressure chambers designed to re-create the home environment. Video cameras, and in some cases a small viewing window, allow scientists to observe the critters.

Such pressurized chambers are being used in a handful of laboratories to keep deep-sea shrimps and crabs alive for long-term studies. At his Southampton lab, Thatje uses one such high-pressure chamber to compare the physiological links between shallow-water and deep-sea animals. He hopes to help answer long-lingering questions about the origins of current deep-sea species.

Scientists believe that the biodiversity seen in the deep sea today evolved from shallow-water creatures that penetrated the depths after major extinction events. Studies suggest that during the warm Mesozoic, 251 million to 65 million years ago, tropical and subtropical conditions extended poleward. Dinosaurs thrived during this time, but life for deep-sea creatures was much different. As waters in the sea stagnated, oxygen levels dropped and life in the deep largely perished. With the onset of glaciation, deepwater circulation was reestablished and the ocean was recolonized by shallow-water species.

Over time, shallow-water animals migrating to the deep would have adapted to the higher pressures. To see how shallow-living animals tolerate deep-sea pressures, Thatje, Shillito and others are subjecting the Atlantic ditch shrimp, native to Western Europe, to pressures similar to those experienced by deep-water cousins living near hydrothermal vents. While applying various pressures and temperatures, the scientists measure the ditch shrimp's oxygen consumption and behavior.

Findings from the studies, published last year in the *Journal of Experimental Biology* and presented at the AAAS meeting in Vancouver, show that the hardy crustaceans survive extreme pressures for periods spanning a few days or weeks.

But survival may depend on the temperature of the water. When tested at temperatures between about 10° and 30° Celsius (50° and 86° Fahrenheit) — similar to those in shallow-water habitats — the shrimps tolerated pressures far beyond what they would normally experience. At even lower temperatures, the shrimps became uncoordinated as pressure increased, and they died within hours.

More recently, Thatje's team studied a group of ditch shrimp living in the pressurized tank for a month. Now, the researchers would like to keep the shrimps under deep-sea–like pressure for a year, to see if the animals can maintain their normal routine on time spans lasting longer than one animal's life.

"We want to see whether the entire life cycle of growth, reproduction and hatching of larvae is really possible at conditions that species never encounter in nature today," he says.

During the experiments, scientists will also collect tissue samples from the shrimps to look for any molecular changes that occur. A few mutations in certain proteins, for example, may turn a normal enzyme into a pressure-resistant one in a relatively short period of time. Such a finding, Thatje says, could reveal new insights into evolution itself.

"Evolutionary processes, by definition, are always thought to be long-term and slow, often taking place over tens of millions of years," he says. "Yet, we know from studies on insects that evolution can be spontaneous. The question is, how much of this holds true for depth-related changes."

Even if shallow-water shrimps can acclimate to the pressure of the dark depths, there's little chance that they'll be heading for the seabed soon. Last year, Thatje and a colleague at Southampton used a deep-sea pressure tank to show that shrimplike animals called amphipods respond to extreme pressures better at high temperatures, such as those near the thermal vents where the amphipods normally live. The findings, published last December in *PLoS ONE*, suggest that temperature, pressure and other factors may work together in complex ways to constrain the habitats animals can call home.

Temperature, pressure and other factors may work together in complex ways to constrain the habitats animals can call home.

Still, some marine animals may be able to make small shifts in their environment due to changing circumstances, such as climate change, says Thatje. The potential for bigger shifts remains unclear.

Despite the recent advances, scientists say that they have only scratched the surface of deep-sea research. Pushing into new realms of the sea will probably yield more clues to how creatures may cope with a changing world. As scientists look deeper, one thing is clear: There's no escaping the pressure. ■

Explore more

■ To see crazy creatures from the deep, visit www.coml.org

A. BROWN AND S. THATJE/*PLOS ONE* 2011

The Cure for Everything

Timothy Caulfield

Don't be misled. This book's satirical title is sorted out in the subtitle: "Untangling Twisted Messages about Health, Fitness, and Happiness." That's the task at hand, and Caulfield leaves few myths unassailed.

He predictably takes a hammer to pseudoscience such as homeopathy. As hundreds or maybe thousands of studies have found, it just doesn't work. But it is heartening to see him also take on stretching, which some still see as a victim of "mixed studies." In reality, study after study has shown that stretching largely fails at its main goal: injury prevention. Cold stretching before exercise, a staple for sports teams and in physical therapy offices, actually risks injury itself. Caulfield cites a U.S. Centers for Disease Control and Prevention review of more than 350 studies on stretching that couldn't find its elusive benefits.

Caulfield's forthright manner is refreshing in a book that actually provides practical health information. He asserts — probably correctly — that eating too much "could very well be the single biggest health issue of the modern age." That's a mouthful, but he backs it up with data from the World Health Organization. Caulfield then grapples with this and other challenges firsthand, subjecting himself to diets, resistance training and more to test what he has learned, providing an amusing journey.

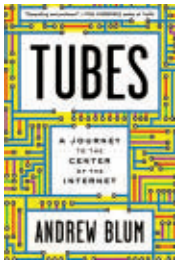
Alas, he delivers the shocking news that most of us will never have rippling abs despite persuasive infomercials. Oh, the horror. Worse yet, people still find flat bellies to be a pleasant eyeful, he says, because of evolutionary programming. "To a savanna-dwelling early man looking for a hot date ... a taut tummy advertised that there was neither a baby on the way nor a new one at home consuming valuable, hard-to-find savanna resources." Well, that explains it. — *Nathan Seppa*

Beacon Press, 2012, 234 p., $24.95

Tubes: A Journey to the Center of the Internet

Andrew Blum

The Internet seems to be everywhere, thanks to the wonders of Wi-Fi: the home office, the local coffee shop, even aircraft cruising at 30,000 feet. Yet the largest technological construction that people interact with on a daily basis has its limits. It is, after all, a network of parts and pieces, from dusty desktop routers and squirrel-gnawed phone lines to transoceanic cables and enormous data storage centers.

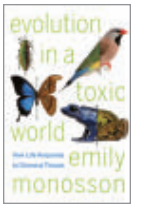


Inspired by an Internet outage in his neighborhood one cold winter day, science writer Blum embarked on a journey to visit the invisible realm beyond his computer screen. His expedition took him from the equipment beside his couch to a battleship-gray junction box on a telephone pole behind his apartment building and beyond.

In this charming chronicle, Blum reveals the inner workings of the Internet — how, as U.S. Sen. Ted Stevens of Alaska described it in 2006, a "series of tubes" shuttles information via massive hubs in metropolitan areas. Though Stevens was ridiculed by late-night comics at the time, Blum notes that he was largely right: Much of the Internet's data traffic travels via tubes filled with copper wires or fiber-optic cables.

Born as a tenuous connection between computer networks at Stanford and UCLA in 1969, the Internet is now a robust network used by more than 2 billion people a day. *Tubes* is an absorbing tale of this new technology, as well as a wonderful account of the Internet's growth and the people who made it possible. — *Sid Perkins*

Ecco, 2012, 304 p., $26.99



Evolution in a Toxic World

Emily Monosson

A toxicologist traces how life evolved to deal with toxic substances and how this plays into chemical exposures today. *Island Press, 2012, 232 p., $35*

Dolphin Confidential

Maddalena Bearzi

A marine biologist chronicles her life in the field and offers an insider's view of how scientists study marine mammals in the wild. *Univ. of Chicago, 2012, 216 p., $26*

Transit of Venus

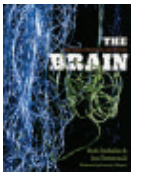
Nick Lomb

This illustrated history recounts the scientific contributions and adventures of the 18th and 19th century astronomers who traveled the world to observe Venus passing in front of the sun. *The Experiment, 2011, 228 p., $24.95*

Learning from the Octopus

Rafe Sagarin

Octopus defenses, marmot lie detection, salmon suicide and other natural phenomena provide inspiration for ways to improve national security. *Basic Books, 2012, 320 p., $26.99*



The Brain

Rob DeSalle and Ian Tattersall

Superbly simple illustrations by Patricia J. Wynne complement this road map to the brain's evolution. *Yale Univ., 2012, 368 p., $29.95*

How to Order To order these books or others, visit www.sciencenews.org/bookshelf. A click on a book's title will transfer you to Amazon.com.

Dark matter inspiration

On reading Tom Siegfried's editorial "Dark matter nothing to fear, if it's there or not" (*SN: 5/19/12, p. 2*):

As into the universe I did stare
I met a particle that wasn't there
It wasn't there again today
Oh, I wish it would go away.

Tom Derderian, Winthrop, Mass.

Reality bits

Regarding "Bits of reality" (*SN: 4/7/12, p. 26*): There may be a catch in the hypothesis that the rules of information processing determine physical theory. This idea appears to be based upon axioms such as causality — in essence, the notion that signals from the future cannot affect the present. This may break time symmetry in the equations of quantum mechanics. In fact, an article by Yakir Aharonov and colleagues ("A time-symmetric formulation of quantum mechanics," *Physics Today*, November 2010) addresses this question. Simple experiments have been proposed to demonstrate signaling from future to present. By now, some of them may actually have been performed. If this is ever demonstrated to occur, we may have a historic scientific discovery of great importance.

Richard K. Bernstein, Mamaroneck, N.Y.

Smoking out ammunition

Residue analysis will help identify only the make of ammunition fired — not the gun in which it was fired ("Smoking out clues from gun residue," *SN: 5/5/12, p. 16*). And if the ammo was hand-loaded (i.e. "homemade"), all it can do is point to the makers of the various components: bullet, powder and primer.

Walter Weller, online comment

Raman spectroscopy revealed chemical signatures for several different calibers of ammunition. If a suspect was found in possession of a firearm and an analysis of gunshot residue at the scene was from a different caliber gun, the data could rule out the suspect's gun. Such data alone cannot prove that a specific gun was used at a crime scene, but the researchers speculate that with a large enough library of spectral data it may be possible to link residue to an individual gun. Hand-loaded ammunition could make identification difficult. — Rachel Ehrenberg

Defining alien life

I am disappointed in the tone of "Aliens in Antarctica" (*SN: 5/5/12, p. 20*). Suppose it could be conclusively determined that some of these organisms reached Antarctica without the influence of humans: Would they still be considered unwelcome invaders, or would their arrival be deemed natural, and therefore acceptable?

Dawn Nelson, Henderson, Nev.

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

PANSCOPE
(the complete optical system) from us only $59.95
(Why pay more?) *

* BUT READ THIS MESSAGE FOR AN EVEN MUCH BETTER DEAL.

This is a little optical marvel. PANSCOPE (only 2" long) contains a complete optical system in its tiny body. You may use it as a 3x telescope or as a unique 3x telescope-loupe. In its magnifying mode, it delivers magnifiers and loupes at 5x, 10x, and 15x enlargement. And to top it all, it also functions as a 30x microscope of laboratory quality.

A special stand for long-term observation for 15x and 30x microscope is included. PANSCOPE is the indispensable first choice of scientists and professionals and of just about everybody who wants and needs to see the infinite detail in life that is not readily available to the unaided eye.

*And here is the even better deal: Buy two PANSCOPES for $119.90 and we shall send you a third one, with our compliments -- absolutely FREE! You will be delighted with this wonderful instrument. Do yourself a favor and order your PANSCOPE(s) today!

• PANSCOPE is beautifully gift-boxed, comes with its neatly fitted leather case and with a plastic "tripod" for extended observations at 15x and 30x.

How to order

You may order by toll-free phone, mail or by fax and pay by check or AmEx/ Visa/ MasterCard. Please give order code shown below. Add $6.95 for one, $9.90 for three instruments for shipping/ insurance- and sales tax for CA delivery. You have thirty-days refund and three-year warranty. We do not refund postage. For customer service or wholesale information please call (415) 356-7801.

Please give order code Z385.

jomira
division of jomira/advance
470 3rd St., #211, San Francisco, CA 94107

Order by toll-free phone: 1-800/600-2777, or (fastest!) by fax: 1-415/356-7804.
Visit our website at www.jomira.com

HAND-CRAFTED WITH AN ORBITING
GIBEON METEORITE BAND
IN 18K GOLD SET WITH 9 GEMSTONES
THE NINE PLANETS RING

JEWELRYDESIGNSFORMEN.COM
831.336.1020

Give the gift of
ScienceNews
Save time, save money and give the magazine that covers science in a biweekly, user-friendly format.

www.sciencenews.org/gift

Marketplace

The Science Life

For more of The Science Life, visit **www.sciencenews.org/people**

The Ngozumpa glacier in Nepal is covered in dirt and debris churned up as the glacier grinds down Himalayan peaks.

Science at 15,000 feet

It's only natural that for her Ph.D. research, Ulyana Horodyskyj found herself rappelling down a Himalayan cliff. After all, she got bitten by the mountaineering bug at age 6, when she witnessed her first avalanche in the Swiss Alps.

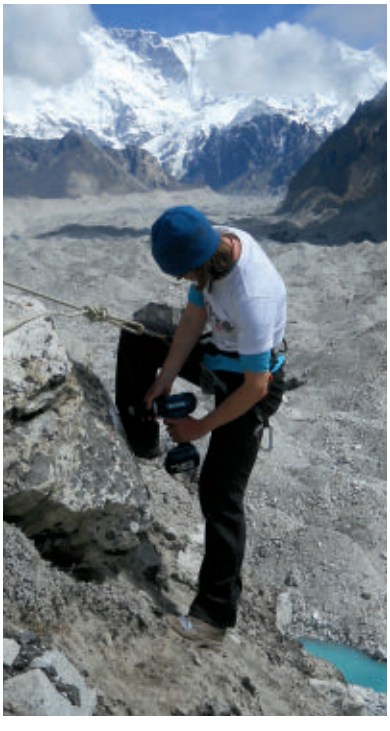
Trained first in astrophysics, Horodyskyj is now a graduate student at the University of Colorado Boulder, a school where rock climbing and glaciology go hand in hand. For a month last summer she crawled over and up the ice and rock of the mighty Ngozumpa glacier in Nepal, almost within spitting distance of Mount Everest.

Her goal: to capture the mercurial behavior of the lakes that appear and disappear atop the glacier. Villages downstream are at risk of flooding from these lakes when water levels rise quickly from melting ice. Water can just as rapidly vanish if cracks in the ice open and allow water to drain to where the glacier meets underlying rock.

Rappelling down cliffs alongside Ngozumpa, Horodyskyj drilled holes into the vertical rock and installed three cameras to snap hourly pictures of several lakes. The work paid off in one lake, where her instruments documented the vanishing of more than 100,000 cubic meters of water in two days — 42 Olympic-sized swimming pools' worth, or more than double the normal melt runoff. "We got lucky — we captured the drainage as it happened," she says. It was the first such documentation in the Himalayas.

Glaciologists have assumed that sudden drainages must be happening in these glacier-top (or "supraglacial") lakes. But without on-the-ground evidence, Horodyskyj says, those assumptions would have remained assumptions. "Things are changing in ways you just cannot tell from satellite imagery," she says.

Hard physical labor at altitudes of 4,500 to 4,800 meters isn't the career for everyone, Horodyskyj admits. "You don't want to mess with mountains." But when she took local villagers on a tour of the lake that had suddenly drained, she was reminded how understanding the physics of a glacier's change affected people's everyday lives. — *Alexandra Witze*



Ulyana Horodyskyj drills holes in cliff faces overlooking Ngozumpa glacier to install cameras that capture the rise and fall of lakes on the glacier's surface.

FROM TOP: U. HORODYSKYJ/CIRES, UNIV. OF COLORADO; ANG PHULA SHERPA/PEAK PROMOTION

How to Make a Splash Without Getting Wet

Bring home 300 carats of aquamarine, the legendary "sailor's gem". In history it's considered the most precious of gemstones — now for under $130!

This is not a necklace. It's the World's Most Beautiful Personal Flotation Device. Ever since ancient times, sailors have sworn by aquamarine for protection on the open water. For them, it was a sacred gem connected to Neptune. But today you don't have to leave shore to reap the benefits of this legendary blue gem, because your ship has come in. Today, you can wear this spectacular ***300-Carat Maré Aquamarine Necklace for only $129!***

Stauer Exclusive! Order today to get 67% OFF!

Claim your "Mermaid's Treasure." On any vessel crossing the oceans, there was no more precious cargo than aquamarine. Sailors paid handsomely for its power, considering it their most valuable commodity. In scientific terms, the chemical composition of our ***Maré*** Necklace beads are cousins to precious emeralds. They begin life as geological twins underground, colorless until something sparks a change. Sprinkle in a dash of minerals and one becomes vivid green and the other becomes brilliant blue. That's the beauty of chemisty.

A legend among luxury jewelers. Named for the Latin words for "water of the sea," aquamarine shines with all the colors of the ocean. Each bead is like a droplet of the sea frozen in space and time. Walk into the most exclusive retail jewelers and you'll find aquamarine in a place of honor. Fifth Avenue thinks nothing of offering a strand of aquamarine "pebbles" for $12,000. But with a color this captivating, you deserve more than a dollop. That's why we collected the bluest stones from three continents, polished them to perfection and arranged them in this double-stranded, 300-carat masterpiece.

Order now and we'll send you the 20" ***Maré Aquamarine Necklace***, featuring two loops of graduated beads with a lobster clasp and spacers layered in gleaming 14K gold. Previously offered for $395, this necklace is yours today for only $129! Nobody but Stauer can give you this much genuine aquamarine for so little.

Your Satisfaction is Guaranteed. If you don't fall in love with the ***Maré***, send it back within 30 days for a complete refund of your purchase price. It's that simple. Call now to set sail on your own incredible aquamarine deal while they last!

JEWELRY SPECS:
- 300 ctw of genuine polished aquamarine
- 14K gold-layered spacers and clasp

Maré Aquamarine Necklace (300 ctw) ~~$395~~
Now only $129

Call now to take advantage of this extremely limited offer.

1-888-373-0654

Promotional Code MAN119-01
Please mention this code when you call.

Stauer®
14101 Southcross Drive W.,
Dept. MAN119-01
Burnsville, Minnesota 55337
www.stauer.com

Stauer has a **Better Business Bureau Rating of A+**

Limited to the First 1,500 Responders!

300 Carats for $129!

Necklace enlarged to show luxurious color.

Smart Luxuries—Surprising Prices

ADVERTISEMENT

Revolutionary Emergency Alert Technology…

"I was so amazed to see the ambulance and wondered, How did they know I fell?"

Arlene A.

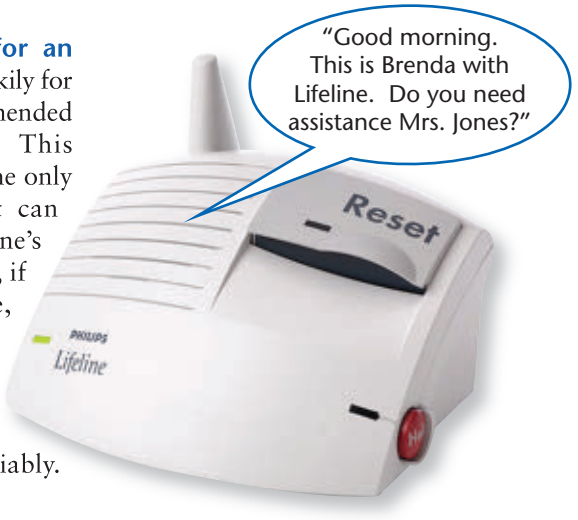
No Long-term Contract! Shipping is Free

Philips Lifeline with AutoAlert is the only Medical Alarm pendant that automatically calls for help if it detects a fall.

For millions of Americans, the fear of falling in and around their home, when they are all alone, is one of the greatest fears of all. Many have tried to protect themselves by purchasing PERS, or Personal Emergency Response Systems. That's a smart move… but it wouldn't have done Arlene any good. She fell in her driveway on a cold winter morning. She hit her head and was so dazed that she didn't think to press the button on her PERS pendant. Suddenly she was amazed to see an ambulance coming up the street. She wondered, "How did they know I fell?"

America's #1 Medical Alarm Service*

Lifeline with AutoAlert…** for an added layer of protection.** Luckily for Arlene, her doctor had recommended Lifeline with AutoAlert. This revolutionary system features the only Medical Alarm pendant that can automatically call Philips Lifeline's state-of-the-art response center, if it detects your fall. There, expert emergency response operators quickly call friends, family or local ambulance, police or firefighters to summon help… quickly and reliably.



Remarkably sophisticated… easy to use. Philips has been around for over 100 years and since the early 70's has led the way in PERS innovations and has more subscribers than any other medical alarm company. Now, they've introduced AutoAlert. All you do is plug the base unit into a power outlet and a phone land line. Then, you wear the AutoAlert pendant. If you experience any kind of emergency, from fires to falls, a break-in or even just shortness of breath, press the button and it calls the Philips Lifeline Emergency Response Center. If you fall and can't press the button for any reason, AutoAlert can automatically call for you, if it detects your fall. Philips Lifeline Response Center Associates are trained to assess the situation and will summon help quickly.

Don't wait another minute… call now! *first*STREET is proud to offer Lifeline with AutoAlert at a special introductory price. There's no equipment to buy, no long-term contract and the setup takes only seconds. Call now and find out how you or a loved one can get this added layer of protection to help you stay living independently in your home.

Evolution of the Personal Medical Alarm

Time	Product	Wireless	Range	AutoAlert
Early 1970s	W. Hormanns "Elder alarm"	No	?	No
1974	Lifeline	Yes	Limited	No
1999	911 Cell Phone	Yes	where service available	No
2010	Philips Lifeline with AutoAlert	Yes	800 ft***	YES

Call now and get Free Shipping

Please mention promotional code 44708.

1-877-734-9213

• No Equipment Cost • No Installation fee

• Just pay as you go!

firstSTREET for Boomers and Beyond®

PHILIPS Lifeline

80457

*Based on number of U.S. subscribers December 2011. **AutoAlert does not detect 100% of all falls. If able users should always push their button when they need help. *** Based on open field test. Copyright © 2012 by *first*STREET for Boomers and Beyond, Inc. All rights reserved.