Chimp Traditions | Function Without Form | Life on Exomoons

ScienceNews

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MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ FEBRUARY 9, 2013

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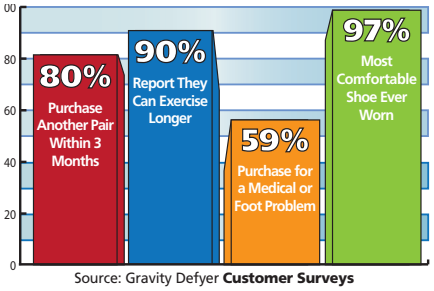

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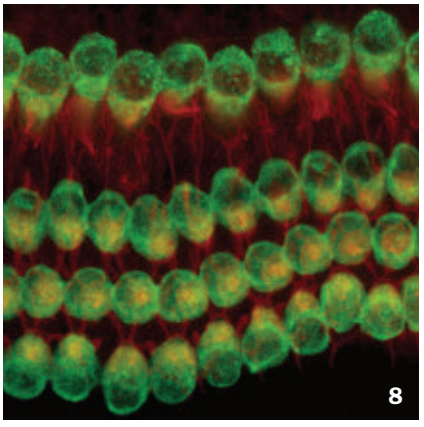

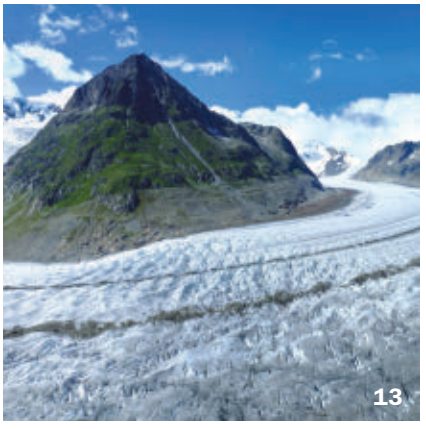

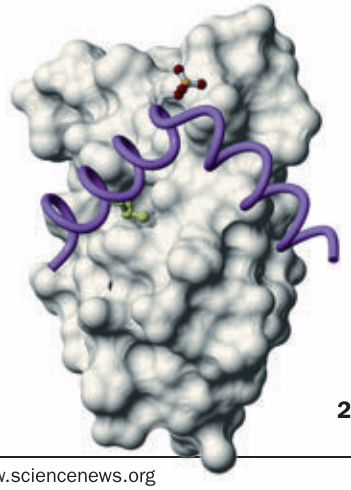

ScienceNews

In The News

Features

Departments

COVER Urban life may be to blame for a recent worldwide increase in myopia. *City: JayLazarin/Istockphoto; glasses: Vstock LLC/Getty Images*

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FROM THE EDITOR

Science brings formerly fuzzy thinking into focus

Glasses, I have always assumed, were my destiny. My mother needed thick lenses by the time she was in kindergarten. My father's nearsightedness didn't emerge until his late teens, but by the time I was born he needed glasses to see anything more than a yard or two away. So when things started to look a bit blurry as I emerged from long studying bouts in the library at college, I just thought that my genetics had finally caught up to me and made an appointment with the optometrist.

Scientists have long thought along similar lines, assuming that myopia is largely genetic. But, as biomedical writer Nathan Seppa reports on Page 22, new research suggests a more complicated — and flexible — scenario. Studies have failed to find an overwhelming hereditary signal for nearsightedness. Instead, scientists have discovered the importance of daily behaviors, specifically the amount of time spent outdoors in childhood and young adulthood, for normal eye development. In studies of children, the amount of time spent outside seems to outweigh genetics or even the amount of reading and other near work in predicting who will need glasses.

That's the good news. The bad news is that myopia rates, especially in young people, are on the rise. And the largest increases are hitting young adults in cities. One study found that among college students in Shanghai, about 95 percent of those examined were nearsighted. Intensive reading and computer work in youth may or may not worsen eyesight — the research isn't entirely clear. But time spent doing these activities is time spent indoors. And that means less time outside, where the eye is exposed to still-unidentified factors that promote healthy eye growth. At least one study is now looking at whether sending kids outside more will help.

Foiling assumptions is one of the most satisfying endings to any science tale. On Page 26, Tanya Lewis highlights another example — a loosening of the dogma that in proteins, structure always determines function. Once considered dysfunctional, proteins without a rigid 3-D structure are now recognized as performing key jobs in the cell, work that may even get a boost from the proteins' floppy, flexible form.

Genetics is not always destiny. Important work can come from disorder. These stories are a reminder that biology, and life, can be a lot more fluid than most assume.

— Eva Emerson, Editor in Chief

PHILIP CHANNING

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Say What?

Nuptial gift ***NUHP-shuhl gihft***\ ***n.***

A gift, often food, that a male offers to a female before mating. Some insects and spiders present prey or other tidbits to distract females while the male transfers his genetic material. Southern ground crickets take it a step further—females mount the male, chew off part of his leg (shown) and sip his circulatory fluids. Nicholas DiRienzo of the University of California, Davis and a colleague report in the February *Ethology* that while this ritual doesn't help a male's chances of transferring sperm, it does increase the number of eggs the female lays by about 44 percent, suggesting that the gift is an investment in future offspring. —*Allison Bohac*

Science Past | FROM THE ISSUE OF FEBRUARY 9, 1963

DIG DITCHES WITH ATOMS — Digging earth by atomic explosions is proving successful, but if President Kennedy's suspension of underground atomic testing on Jan. 26 is maintained, the method may not be used practically. Future excavation experiments are described for the first time by the Atomic Energy Commission in its annual report to Congress. The AEC says underground blasts can be used for canal construction, harbor excavation, recovery of minerals, oil or water, processing of chemicals and desalting water. Detonations of useful, peace-serving atomic and hydrogen "bombs" are of two kinds — cratering, or earth-moving, and confined explosives. There are 11 projects, collectively named Plowshare, for both types on the AEC underground explosion schedule.

Science Future

February 16–17
Kids can see science demonstrations, learn about cool science careers and talk to scientists at the annual Family Science Days at the American Association for the Advancement of Science meeting in Boston. Learn more at bit.ly/SFfamday2013

March 7
The Creatures of Light exhibit on bioluminescence comes to Chicago's Field Museum. Find more information at bit.ly/SFfieldlight

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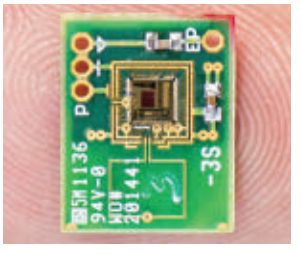
MATH TREK
Economists say auction-based purchasing could create market chaos. See Julie Rehmeyer's column "Devil is in the details of a new Medicare plan to buy medical supplies."

SCIENCE NEWS FOR KIDS
Research in guinea pigs finds a way to power small electronic devices using a voltage difference in the inner ear. Read more in "Your head's battery."



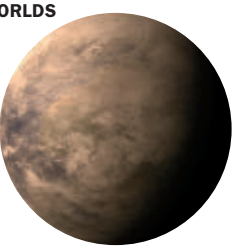
RANDOMNESS
Tom Siegfried's column "Maybe there's a way to find out if reality is a computer simulation" explores how computers describe the universe.

How Bizarre | BE STILL MY GILLS

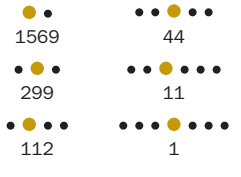
The sensory abilities that alert adult sharks to electric fields generated by a nearby meal may keep baby sharks from becoming dinner themselves. Bamboo sharks (*Chiloscyllium punctatum*) develop inside a leathery egg case (left) that opens slightly near hatching time. This allows seawater in but may also allow predators to sniff out young sharklets. Fortunately, the baby sharks' sensing machinery is up and running: When exposed to an electric field like that of a predator, the babies go completely still, even appearing to cease breathing, University of Western Australia scientists report January 9 in *PLOS ONE*. Studying the species' response to electricity could lead to better shark-repelling devices, the researchers say. —*Rachel Ehrenberg*

Science Stats | MORE NEW WORLDS

A new haul of planet candidates from NASA's Kepler space telescope includes 10 worlds slightly larger than Earth that could harbor liquid water and life. Kepler has now found 30 of these warm super-Earths (one illustrated at right), though the ultimate goal is to find planets with sizes and temperatures nearly identical to Earth. The mission is also uncovering crowded solar systems — almost a quarter of the planet-bearing stars host multiple worlds (bottom right). —*Andrew Grant*



Solar systems found, by number of planets



SOURCE: PHL/UPR ARECIBO

CLOCKWISE FROM TOP: COURTESY OF N. DIRIENZO; P. MERCIER *ET AL/NATURE BIOTECHNOLOGY* 2012; PHL/UPR ARECIBO; R.M. KEMPSTER *ET AL/PLOS ONE* 2013

“If we at some point really want to go to Mars and we want to send humans, then we need to know how they will cope with this long period of confinement.” —MATHIAS BASNER, PAGE 8

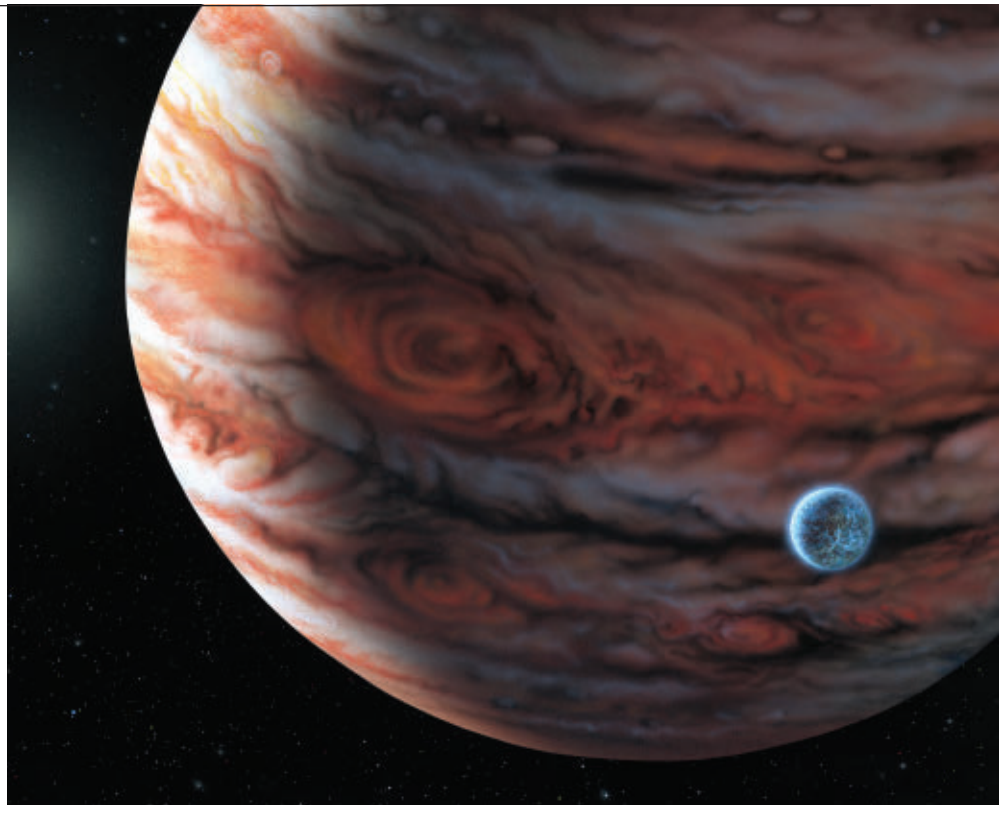
In the News

STORY ONE

Life could survive on Earth-sized moons of gas giant exoplanets

If they exist, distant worlds have good odds of habitability

By Andrew Grant



LYNETTE COOK/SCIENCE SOURCE

Jupiter-like gas giants (illustrated at center) in other solar systems may host moons that could support life (right). To be habitable, such bodies would need to be the right size, orbit at the proper distance from their host planets and have a manageable level of exposure to stellar radiation.

Earth-sized moons in planetary systems trillions of miles away could be hotbeds for alien life, astronomers report in the January *Astrobiology*.

“It’s the most thorough look at exomoon habitability I’ve seen,” says Darren Williams, an astronomer at Penn State Erie who was not involved in the research. “I’m encouraged by the paper that we’ll find exomoons in abundance and that a fraction of them could be habitable.”

Astronomers have found about 3,600 confirmed or probable planets orbiting other stars, none of which have the ideal combination of size and temperature to support life. However, more than 150 are gas giants in orbits where liquid water could exist, if only it had a solid surface to puddle on. Life might be able to survive on rocky moons of those Neptune- and Jupiter-like planets.

The bounty of temperate giants led astronomers René Heller of Germany’s Leibniz Institute for Astrophysics Potsdam and Rory Barnes of the University of Washington in Seattle to examine all the factors that determine the habitability of exomoons. Moons are substantially more complicated than planets because they are at the mercy of both their host planet and star: The star pelts them with radiation and so does the reflection off the top of their planet’s gaseous clouds. Jupiter, for example, reflects about a third of the solar radiation that strikes it. Moons also get squeezed and deformed by the gravitational pull of their massive planetary companions, a phenomenon called tidal heating that supplies yet another source of energy.

These interactions with planet and star lead to some downright odd conditions. At times one region of the moon could have both the star and planet in its sky, providing plenty of energy, while another region would be in complete darkness. Minutes- or hours-long eclipses of the star by the giant planet would be a frequent occurrence. Nonetheless, the researchers found that an exomoon’s average influx of energy could be sufficient to support life.

Perhaps the biggest obstacle to the habitability of extrasolar moons is their size. Heller and Barnes show that a moon

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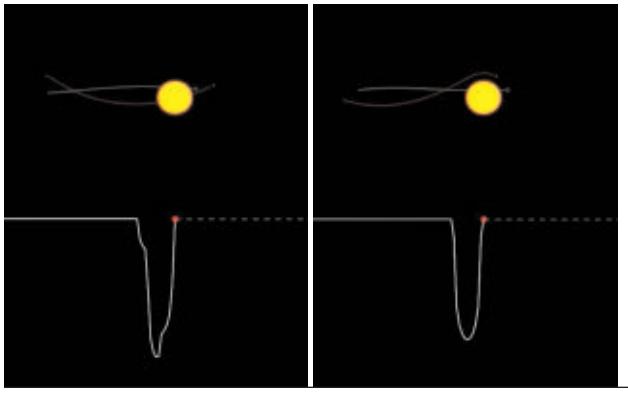


Hunting exomoons
To find an exomoon, astronomers are monitoring regular dips in light caused by a planet's passage in front of its star. A moon would reveal itself by sometimes blocking the star's light along with its planet, producing an uneven dip (left). When the planet alone passed in front of the star, the light dip would be symmetric (right).

needs to be roughly the mass of Earth to maintain an atmosphere and a magnetic field that could deflect deadly radiation from the giant planet next door and other sources. That could be a tough requirement to meet: Jupiter's Ganymede, the largest moon in the solar system, is only 2 percent as massive as Earth.

However, astronomers have proposed ways that giant planets could develop bulkier moons. In an upcoming study, Williams describes how gravitational interactions could lead to a gas giant capturing a terrestrial planet that would then become its moon. Heller agrees that such moons should exist: "When I think of all the weird planets we've found — hot Jupiters, planets orbiting two stars — why shouldn't we be able to find a large moon around a gas planet?"

Heller and Barnes combined all these factors to come up with a new measure called the habitable edge, the minimum distance between a given planet and moon that would allow for life on the moon. Get any closer and tidal heating will take over and sterilize the moon. Heller says that when astronomers eventually discover exomoons in an environment warm enough for liquid water, they can use the bodies' properties to see if there is a chance for life.

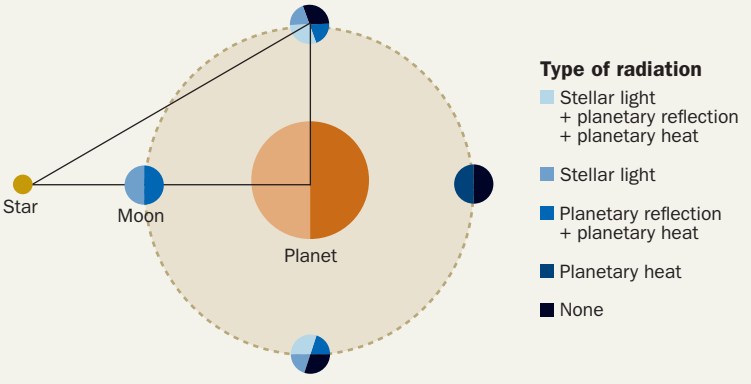
David Kipping, an astronomer at the Harvard-Smithsonian Center for Astrophysics, is leading a dedicated search for exomoons based on data from the planet-hunting Kepler space telescope. He announced January 9 at an American Astronomical Society conference in Long Beach, Calif., that his analyses of seven Kepler planets showed no signs of moons, but he plans on studying over 100 more planets. "It's brilliant to see this kind of research done," Kipping says of Heller and Barnes' study.

Penn State planetary scientist James Kasting shares Kipping's optimism over the new work, but he laments that it will be a long time before astronomers can test the study by probing specific moons for water, carbon dioxide or other signatures of life. Such a feat would require a telescope with enough resolution to filter out the light from stars and planets and focus exclusively on a moon. "You can postulate that habitable moons are out there, but you'll never be able to check it," he says.

Heller concedes that investigating individual exomoons will be difficult, though he points to a recent study asserting that NASA's James Webb Space Telescope, scheduled for launch in 2018, should be able to detect moons surrounding nearby small, dim stars.

Despite sharing Kasting's concerns, Williams focuses on the fact that the paper opens up yet another avenue for alien life to thrive. "Moons just improve the chances that life as we know it exists elsewhere," he says. "The diversity of environments that you can have is just amazing." ■

Back Story | STRANGE DAYS



The pattern of light and darkness on an exomoon would be very different from the relatively consistent 24-hour day-night pattern that prevails on much of Earth. Most exomoons could be expected to keep one face toward their host planet, just as Earth's moon does. That side would cycle from complete darkness when eclipsed by the planet (right) to a twilit state (left), as starlight reflected onto it from the top of the planet's atmosphere. The exomoon's near side would also always receive heat radiated by the planet itself. The exomoon's far side would cycle from direct starlight to complete darkness with every orbit. In the exomoon's quarter phases (top and bottom), different parts of the surface would be exposed to various combinations of direct and reflected starlight.

FROM TOP: ALEX PARKER; T. DUBÉ

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Mind & Brain

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Sleep may suffer on Mars mission

Crew of 520-day simulated trip dozed more but poorly

By Laura Sanders

Astronauts on a long mission to Mars and back will have more to contend with than boredom and a lack of gourmet cuisine: Disrupted sleep may be a serious side effect of extended space flight.

In an epic feat of playacting, a crew of six men lived for 520 days inside a hermetically sealed 550-cubic-meter capsule in Moscow. As the grueling experiment wore on, the crew moved less and slept more. Four men experienced sleep problems, scientists report online January 7 in the *Proceedings of the National Academy of Sciences*.

"If we at some point really want to go to Mars and we want to send humans, then we need to know how they will cope with this long period of confinement," says study coauthor Mathias Basner of the University of Pennsylvania. Basner's team was one of many that studied the six men during the simulation.

Several months into the experiment, crew members seemed to drift into inactivity, sleeping more and moving less, Basner and his team found using wristwatch-like gadgets that measured activity once a minute. On average, crew members slept over half an hour more per day in the last quarter of the mission than in the first.

If a similar torpor strikes people on a real mission, it could have important effects, says coauthor Jeffrey Sutton of the National Space Biomedical Research Institute in Houston and Baylor College of Medicine. Sedentary crews might need to ramp up their exercise to stay healthy in microgravity, for instance.

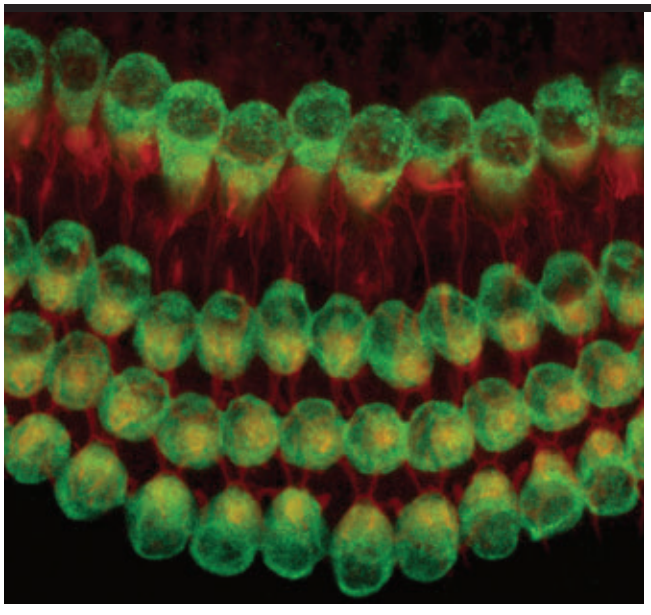
Although on average the crew became lethargic, the responses were by no means uniform. One crew member actually slept less as time wore on, and his performance on a vigilance test suffered, the researchers found. Such a seemingly small problem could have deadly consequences, Sutton says. "When you are doing high-risk behavior in space, a performance deficit can be life-threatening."

Another crew member stretched a normal 24-hour Earth day into a 25-hour pattern of sleeping and waking.

The six-member Mars 500 crew spent 520 days inside a mock space capsule to simulate a flight to Mars. Sleep patterns deteriorated over the mission.

This means that for about a fifth of his time, this man was awake when others were asleep, or asleep when others were awake. "His timing was totally out of whack, and that could cause a huge problem," Basner says.

The simulation results "help us understand what we need to do," says Lauren Leveton of NASA's Johnson Space Center in Houston. Knowing which people might struggle with sleep issues could help space agencies select the best crews and also devise ways to prevent problems from developing.



Drug restores lost hearing

A new drug may be able to combat noise-induced hearing loss. Loud noises can damage sensitive inner ear cells called hair cells (mouse hair cells shown), which in mammals don't grow back. That's why rock musicians, factory workers, carpenters and other people who are surrounded by loud sounds often suffer hearing loss. A study in mice may point out a way to reverse the effects of this acoustical trauma. The compound LY411575, a type of molecule called a gamma-secretase inhibitor, got these hair cells growing again. After receiving an injection of the drug in the ear, mice with cochleas damaged by loud white noise sprouted new hair cells. What's more, these newborn cells partially restored the animals' hearing, researchers led by Albert Edge of the Massachusetts Eye and Ear Infirmary in Boston report in the Jan. 9 *Neuron*. A similar drug may one day reverse hearing loss in people. —*Laura Sanders*

FROM TOP: ESA; K. MIZUTARI *ET AL./NEURON* 2013

"This is a way to see gene influences before the world steps in." —JAY GIEDD

Hints of potential ills in infant brains

Features characteristic of adult-onset diseases seen at birth

By Laura Sanders

At birth, some infants are already saddled with features of Alzheimer's disease and schizophrenia. Newborns who carry certain versions of genes show brain shrinkage reminiscent of that in adults with the illnesses, a study of 272 newborn babies reveals.

The new results, published online January 2 in *Cerebral Cortex*, illuminate what happens to the brain in the earliest stages of life, says neuroscientist Jay Giedd of the National Institute of Mental Health in Bethesda, Md., who was not involved in the study. "As we go through life, there are so many uncontrollable factors," he says. "This is a way to see gene influences before the world steps in."

Until this study, scientists didn't have a good idea of whether certain brain signatures — such as reduced volume in parts of the brain — were present from birth or whether they accumulated over a lifetime, says study coauthor Rebecca Knickmeyer of the University of North Carolina at Chapel Hill.

To test this, Knickmeyer and her colleagues looked for the influence of 10 versions of seven genes on newborns' brains. The researchers chose genes that affect how the brain grows and develops. These gene variants have also been linked to adult brain diseases and include the e4 version of the *APOE* gene, which triples the risk of getting Alzheimer's, and a version of the *COMT* gene, which has been implicated in schizophrenia.

Brains of newborns with some versions of these genes had features similar to those seen in adults with diseases, the team found. Newborns with the e4 version of the *APOE* gene had less brain tissue volume in the temporal cortex, a part of the brain that thins in elderly people and adults who have e4. Newborns with a variant of *COMT* also had reduced volume in the temporal cortex, a brain characteristic that turns up in people with schizophrenia.

The implications are that these brain features are a consequence of genetic influences, Giedd says. "I'm trying not to be doom and gloom, but it's not lifestyle. It's not parenting." Those factors won't change genetic effects on brain volume in a newborn baby, he says.

But Giedd points out that genes aren't destiny, and that having a high-risk gene variant doesn't mean a person will definitely get an illness.

Language skills present at birth

Newborns can tell native from foreign vowel sounds

By Bruce Bower

Babies may start to learn their mother tongues even before seeing their mothers' faces. Newborns react differently to native and foreign vowel sounds, suggesting that language learning begins in the womb, researchers say.

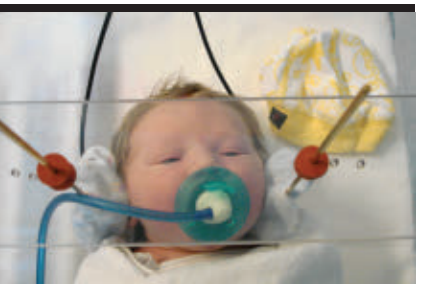
Infants tested seven to 75 hours after birth treated spoken variants of a vowel sound in their home language as similar, evidence that newborns regard these sounds as members of a common category, say psychologist Christine Moon of Pacific Lutheran University in Tacoma, Wash., and her colleagues. Newborns deemed different versions of a foreign vowel sound to be dissimilar and thus unfamiliar, the scientists report in the February *Acta Paediatrica*.

Fetuses can hear sounds outside the womb by about 10 weeks before birth. Until now, evidence suggested that prenatal learning was restricted to the melody, rhythm and loudness of voices. Earlier investigations established that 6-month-olds group native but not foreign vowel sounds into categories.

Moon and colleagues propose that, in the final weeks of gestation, fetuses monitor at least some vowels — the loudest and most expressive speech sounds — uttered by their mothers.

The study "implies that the fetal brain close to birth can perceive and learn most of the key aspects of speech," says psychologist Minna Huotilainen of the Finnish Institute of Occupational Health in Helsinki.

Moon's team studied 80 healthy newborns, half in U.S. hospitals and half in Swedish hospitals. Each infant lay in a crib in a quiet room with soft headphones placed next to his or her ears. By sucking on a pacifier connected to a computer, babies triggered the presentation of vowel sounds for five minutes.



C. MOON

A Swedish newborn takes part in an experiment in which rates of pacifier sucking indicated that babies can tell some native speech sounds from foreign ones within hours of birth.

A vowel sound was played until a newborn stopped sucking for at least one second. A new vowel was presented when sucking resumed. Longer bouts of sucking denoted greater interest in a sound, the researchers say.

On average, newborns sucked their pacifiers more times upon hearing foreign vowels than native vowels. This finding held regardless of time since birth.

Matter & Energy

"There's nothing forbidden about negative temperatures." —ACHIM ROSCH

New clock revolves around mass

Study claims that time can be gauged by an atom's heft

By Andrew Grant

It's part clock, part scale: A newly developed atomic clock measures time based on the mass of a single atom. The research, published online January 10 in *Science*, is controversial but could provide scientists with more precise methods of measuring both time and mass.

"This is the first clock based on a single particle," says Holger Müller, a physicist at the University of California, Berkeley. "Its ticking rate is determined only by the particle's mass."

The idea for the clock stemmed from the quantum principle that particles also behave as waves, and vice versa. In particular, Müller and his colleagues wanted to determine how frequently the wave version of a single atom oscillates, a quantity that in quantum mechanics is inherently linked to the atom's mass. Then the researchers could use those oscillations like swings of a pendulum to create a clock.

The snag in that plan was that it's impossible to directly measure the oscillation of waves of matter. The frequency of these waves is about 10^{25} hertz, 10 orders of magnitude higher than that of visible light waves. So Müller and his colleagues created two sets of waves — one based on a cesium atom at rest and another on the atom in motion. The researchers measured the frequency difference between the waves and then used that number, a manageable 100,000 hertz or so, to calculate the much larger oscillation frequency of cesium at rest.

With this approach, Müller was able to use the wave frequency of the cesium atom to create a clock that would gain or lose a second every eight years. That's better than a wristwatch but about a hundred millionth as precise as today's best atomic clocks, which count the frequency of light emissions from an atom as its electrons release small bursts of energy.

Physicists not involved with Müller's research are impressed with his clever technique, but skeptical about its potential for precise timekeeping. "I think the paper is slightly oversold," says Vladan Vuletić, a quantum physicist at MIT.

Other researchers have a more conceptual objection: Because there is nothing at this frequency actually oscillating within the atom, they say it is not a clock at all. "It may be a clock numerically, but it's not a physical clock," says Christian Bordé, a physicist at the Paris Observatory. Müller counters that the clock's simplicity is its greatest trait: He is measuring an intrinsic quantum property of an atom, one that depends only on the atom's mass.

In fact, this relationship between frequency and mass means Müller's technique may prove most useful as a scale for measuring mass. Scientists define the kilogram with a lump of metal stored in a French vault — a lump that is likely gaining heft from contamination. The International General Conference on Weights and Measures, led by Bordé, wants to replace this artifact with a kilogram standard based on fundamental physical constants.

Müller says he can do just that by measuring the frequency of matter waves.

Hottest temp is a negative one

New record reached with ultracold gas at high energy

By Andrew Grant

Coaxing a gas to a negative temperature on the Kelvin scale has produced, paradoxically, the hottest temperature ever measured.

Temperature is commonly interpreted as a measure of the average energy of the particles in a sample. But for scientists who study matter at quantum scales, temperature is better defined as the energy distribution of those particles. Just above absolute zero (0 kelvin, or −273° Celsius), almost all particles in a sample have energies very close to zero, with little variation. But as temperatures rise, the energy variation widens — some particles still have very small energies, but others have more.

Physicist Ulrich Schneider at the Ludwig Maximilians University of Munich and his colleagues set out to cajole the particles in a substance to be confined to a very high amount of energy. Instead of having the particles start at a minimum energy (corresponding to absolute zero) and spreading out toward higher energies, he wanted to start at a maximum energy and spread toward lower energies. By definition, such a substance would have a negative Kelvin temperature.

"We are used to positive temperatures," says Achim Rosch, a physicist at the University of Cologne in Germany. "But there's nothing forbidden about negative temperatures. It's always fascinating to do something unusual."

Using lasers and magnets, Schneider's team managed to get supercold potassium atoms to jump to a high-energy state. By creating a cluster of particles exclusively at high energies, Schneider and his colleagues had a gas at a few billionths negative kelvin, they report in the Jan. 4 *Science*.

This temperature is technically not below absolute zero. In fact, the new creation is extremely hot because of the high energies of the particles. Heat travels from hot to cold, Schneider says, and heat will always flow away from this gas. "It's actually hotter than everything we know," he says.

Humans

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Pruney fingers get better grip

Wrinkles may be evolutionary adaptation to wet conditions

By Tanya Lewis

Scientists have an answer to the pressing question of why hands and feet get wrinkled after too much time in the bath: Pruniness may have evolved to make it easier to grip wet objects.

Though often assumed to be a result of water passively seeping into the skin, the phenomenon is actually caused by the nervous system constricting blood vessels. But what evolutionary purpose wrinkling serves, if any, has been a mystery.

In 2011, researchers proposed that the grooves in wet fingers might function as "rain treads" that improve grip by channeling water away, much as car tires on a wet road do. Toes wrinkle too, which could have evolved to provide surer footing on slick surfaces. Now, researchers at Newcastle University in England have tested the rain-tread theory.

The researchers had 20 volunteers manipulate objects with smooth fingers or digits shriveled by immersion in warm water. The experimenters measured how long it took people to transfer the objects between a water-filled container and a dry one, or between two dry ones, with wrinkled versus unwrinkled fingers. The objects were glass marbles and fishing weights of various sizes.

All the participants transferred the wet objects (but not the dry ones) faster with pruney hands. The results suggest furrowed fingertips make it easier to handle moist items, the scientists report in the April 23 *Biology Letters*.

The findings don't explain exactly how the wrinkles improve grip. Although the results provide "converging behavioral evidence for the conclusion that wrinkled fingers are rain treads, this could also be true for other reasons, such as stickiness properties or oiliness," says theoretical neurobiologist Mark Changizi of 2AI Labs in Boise, Idaho. Changizi led the team that put forward the rain-tread hypothesis.

The wrinkles that form on people's hands and feet after soaking in water may have evolved to help humans handle wet objects more efficiently.

MITCHIO/FLICKR

Health & Illness

100 percent | Fraction of endometrial cancers detected

41 percent | Fraction of ovarian cancers detected

Updated test spots more cancers

Gene-based Pap smear finds ovarian, uterine malignancies

By Nathan Seppa

A multipurpose version of a Pap smear can detect genetic signs of ovarian or uterine cancer in women, researchers report. When used on cervical swabs, the experimental analysis spotted genetic mutations in every sample from uterine cancer patients and in many from those with ovarian cancer.

The test is far from clinic-ready. But if confirmed in larger studies and developed into a usable "Papgene" test, as the study authors propose, the new approach could change cancer testing in women. The study appears in the Jan. 9 *Science Translational Medicine*.

Although the genetic screen caught uterine cancers more consistently, it is more apt to have a major impact on diagnosing ovarian cancer, says Shannon Westin, a gynecologic oncologist at the University of Texas M.D. Anderson Cancer Center in Houston who wasn't part of the study. While uterine cancers are often found due to vaginal bleeding and diagnosed with ultrasound tests, ovarian cancers remain hidden because they lack obvious symptoms and reliable screening tests.

Researchers identified 12 genetic mutations that show up in uterine or ovarian tumors. The team reasoned that a Pap test could detect these mutations since some cancerous cells get shed from the ovaries and uterus and travel to the cervix, the conical structure where the uterus meets the vagina. A doctor swabs the cervix with a brush to get a sample of cells for a Pap smear, an exam that normally checks for aberrant cell growth related to cervical cancer and can also look for the genetic signature of the virus that causes it.

> "This is really a union of genomic medicine with just clinical anatomic know-how."
> LUIS DIAZ JR.

The researchers tested 46 Pap smears from cancer patients. The test found at least one genetic mutation in all 24 samples taken from uterine cancer patients and in nine of 22 samples from ovarian cancer patients. Many of the cancers were still in an early stage at the time the Pap smears were performed, says study coauthor Luis Diaz Jr., an oncologist at Johns Hopkins University.

Tests on Pap smears from 14 women without cancer showed no signs of the 12 mutations.

Diaz says he expects that more mutations will be added to the analysis as they prove specific to these cancers. "This is really a union of genomic medicine with just clinical anatomic know-how," he says. If the test were available today, he estimates it would add about $75 to the cost of a Pap smear.

Disabled virus keeps HIV at bay

Some patients respond to experimental vaccine therapy

By Nathan Seppa

Injecting heat-inactivated HIV can awaken immune protection against the virus in some patients, limiting their need for drugs for weeks or months. While the effects appear temporary, the approach might eventually lead to a way to control HIV over the long term.

The immune system is understaffed in the fight against HIV, largely because the virus targets the very immune T cells that coordinate defense against the virus. Efforts to alert these and other immune forces to the presence of HIV in already infected patients through vaccination have produced mixed results.

The new study, published January 2 in *Science Translational Medicine*, reports on an approach that can lower virus levels substantially. Using blood samples from 36 patients, researchers extracted each person's HIV and a sampling of immune system cells called dendritic cells. For 22 randomly selected patients, the scientists blasted the HIV with heat to inactivate it. The patients then received as a vaccine their own dendritic cells and inactivated HIV. Over 12 weeks, virus levels plummeted by at least 90 percent in 12 of the 22 volunteers.

The result suggests that dendritic cells toting inactivated HIV can direct an immune onslaught toward live virus circulating in patients, says study coauthor Felipe García, an infectious disease physician at the University of Barcelona. Patients who received their own unchanged HIV and dendritic cells as a control group showed little benefit.

In most of the treated patients, the newfound immunity to HIV faded over time and virus levels rose. After 48 weeks, only three who got the therapeutic vaccine still maintained the 90 percent drop in virus levels.

All the patients had been taking standard antiretroviral therapy beforehand. Previous attempts at using a vaccine to gin up an immune response in patients who hadn't been taking the standard medications failed. "It is likely that the person's immune system is already damaged, and so they cannot mount a sufficiently efficient functional antiviral response" to a vaccine, says Anders Fomsgaard, a physician at Statens Serum Institute in Copenhagen. "It may be more optimal to vaccinate during antiretroviral therapy."

He says the reduction in virus levels seen in the new study is promising.

Earth

"For Tohoku, it's a fairly convincing scenario. But it's not the only scenario." —KELIN WANG

Faults weakened by nearby quakes

Simulation could explain how quiet zones can awaken

By Erin Wayman

Some geologic faults suffer from a Jekyll and Hyde personality: Sections considered resistant to powerful earthquakes can sometimes produce enormous temblors. New research shows how a quake on one fault segment can weaken a stable neighboring section, allowing it to suddenly slip.

The findings could explain why Japan saw the devastating March 2011 Tohoku quake on the fault segment it did. Seismic hazards in many other fault zones may also need to be reassessed, scientists report online January 9 in *Nature*.

"For Tohoku, it's a fairly convincing scenario," says Kelin Wang, a geophysicist at the Geological Survey of Canada in Sidney. "But it's not the only scenario."

Seismologists have traditionally expected faults to either creep along at a steady pace or be stuck, slowly building up energy that is suddenly unleashed in an earthquake. Creeping faults shouldn't generate giant quakes because they release energy gradually. That's why the magnitude 9 Tohoku earthquake was a surprise: It largely occurred on a fault segment assumed to be creeping.

That segment—which slipped by as much as 50 meters during the quake—ruptured roughly 7 to 15 kilometers beneath the seafloor near the Japan Trench. The trench marks the beginning of a subduction zone, where the west-moving Pacific plate of Earth's crust dives beneath the plate that carries northern Japan. Large seismic events weren't expected in such a shallow portion of a subduction zone. With less overlying material, the shallow end should experience less compression and therefore be stronger than deeper segments, says study coauthor Nadia Lapusta, a solid mechanics specialist at Caltech.

In the new study, Lapusta and Hiroyuki Noda of the Japan Agency for Marine-Earth Science and Technology in Yokohama simulated how nearby seismic activity can weaken a stable, creeping fault segment. If a quake on one segment generates heat fast enough, it causes water to expand in tiny pore spaces in the rocks of an adjacent segment. As water pressure builds, the fault weakens, friction drops and the quake can rupture the normally resistant fault segment.

The simulation is based on the properties of rocks collected from boreholes in the Chelungpu fault, the site of a magnitude 7.6 earthquake that struck Taiwan in 1999. Because the results re-create observations from the Tohoku quake, the study probably explains what happened in Japan in 2011, Lapusta says.

But some scientists say it's too soon to make that conclusion. "A specific connection to Japan is a stretch," says Thorne Lay, a seismologist at the University of California, Santa Cruz. Little is known about the actual frictional properties of the fault segment that slipped during the Tohoku event, he says. And scientists don't really know whether the fault was creeping or locked before the earthquake because the region's network for monitoring ground movement is based on land. Japan is now working to build such a network on the seafloor near the Japan Trench.

JEAN BRAUN

Glaciers carve future ice paths

By carving wide valleys into mountain landscapes, glaciers such as Switzerland's Aletsch Glacier (shown) prime a region for even more extensive glaciations in the future, researchers report in the Jan. 10 *Nature*.

Vivi Pedersen of Norway's University of Bergen and David Egholm of Denmark's Aarhus University simulated how mountain glaciers form when a climate grows colder. In mountains marked by steep, narrow valleys, ice volume steadily increases as temperatures drop and snow begins to fall at increasingly lower altitudes. But in flatter regions previously covered by glaciers, ice builds more rapidly because snow has more surface area to accumulate on.

The findings suggest a proliferation of mountain glaciers around 950,000 years ago occurred because earlier, smaller streams of ice had prepared areas for widespread glaciations. —*Erin Wayman*

Science & Society

For more about this year's Intel Science Talent Search finalists, visit **www.societyforscience.org/sts**

STS finalists bound for Washington

Forty vie for top awards in 2013 Intel Science Talent Search

By Matt Crenson

Young researchers from 21 states have made it to the final stage of the 2013 Intel Science Talent Search, earning the chance to compete for a total of $630,000 in awards.

The finalists will visit Washington, D.C., March 7–13 to see the White House and other national landmarks, present their research in a poster session at the headquarters of the National Geographic Society and attend a black-tie awards gala at the National Building Museum.

"We commend the 40 Intel Talent Search finalists on their successes so far and look forward to watching them progress not only during the finals in Washington, but also in their future careers," says Elizabeth Marincola, publisher of *Science News* and president of Society for Science & the Public, which has operated the competition since 1942. Intel has sponsored the program for 15 years.

Many past Science Talent Search finalists have gone on to distinguished research careers. Alumni have won a total of seven Nobel Prizes, two Fields Medals, five National Medals of Science and 11 MacArthur Foundation Fellowships.

The finalists were chosen from more than 1,700 entries.

"This year's ... finalists are presenting a wide range of research, from optimizing algae oil for biofuel to developing a new treatment for blood cancer," says Wendy Hawkins, executive director of the Intel Foundation. "It's exciting for the future of innovation because the U.S. needs these 40 high school seniors, and others like them, to question, explore and help solve some of the world's greatest challenges."

Last year's top award went to Nithin Tumma of Fort Gratiot, Mich., who did research on a protein that helps cancer evade the body's immune system. Also honored were Andrey Sushko of Richland, Wash., who created a tiny motor just 7 millimeters across that draws its power from the surface tension of water, and Mimi Yen of New York City, who studied genetic influences on mating behavior in the worm *Caenorhabditis elegans*.

THE FINALISTS

ARIZONA **Annie Dai,** Phoenix, Desert Vista High School

CALIFORNIA **Pavan Mehrotra,** Simi Valley, Sierra Canyon School; **Kevin Chen,** Fremont, Mission San Jose High School; **Kelly Zhang,** Orinda, The College Preparatory School; **Sahana Vasudevan,** Palo Alto, Gnyanam Academy; **Jack Takahashi,** Saratoga, Lynbrook High School; **Paulomi Bhattacharya,** Cupertino, The Harker School

COLORADO **Sara Volz,** Colorado Springs, Cheyenne Mountain High School

CONNECTICUT **Stephen Le Breton,** Greenwich, Greenwich High School

FLORIDA **Brittany Wenger,** Sarasota, Out-of-Door Academy

GEORGIA **Lillian Chin,** Decatur, The Westminster Schools; **Raja Selvakumar,** Alpharetta, Milton High School

ILLINOIS **Lane Gunderman,** Chicago, The University of Chicago Laboratory High School

INDIANA **Peter Kraft,** Munster, Munster High School

KENTUCKY **Naethan Mundkur,** Louisville, duPont Manual High School

MASSACHUSETTS **Jacob Johnson,** Boxborough, Acton-Boxborough Regional High School; **Surya Bhupatiraju,** Lexington, Lexington High School

MARYLAND **Samuel Zbarsky,** Rockville, Montgomery Blair High School

MICHIGAN **Lilia Popova,** Ann Arbor, Ann Arbor Huron High School

NEW JERSEY **Jennifer Chan,** Upper Saddle River, Academy for Medical Science Technology; **Catherine Wong,** Morristown, Morristown High School

NEW MEXICO **Katherine Cordwell,** Albuquerque, Manzano High School

NEW YORK **Samantha Scibelli,** Burnt Hills, Burnt Hills-Ballston Lake High School; **Jiayi Peng,** Chappaqua, Horace Greeley High School; **Chris Traver,** Croton-on-Hudson, Croton-Harmon High School; **Mayuri Sridhar,** Kings Park, Kings Park High School; **Jamie Solimano,** New York, Stuyvesant High School; **Daniel McQuaid,** Ossining, Ossining High School; **Michael Zhang,** Saint James, Smithtown High School East

OREGON **Hannah Larson,** Eugene, South Eugene High School; **Naomi Shah,** Portland, Sunset High School; **Raghav Tripathi,** Portland, Westview High School

PENNSYLVANIA **Joy Wang,** Orefield, Parkland High School; **Jonah Kallenbach,** Ambler, Germantown Academy; **Meghan Shea,** West Chester; Unionville High School

TENNESSEE **Akshay Padmanabha,** Collierville, Houston High School; **Adam Bowman,** Brentwood, Montgomery Bell Academy

TEXAS **Kensen Shi,** College Station, A&M Consolidated High School

VIRGINIA **Alexa Dantzler,** Manassas, Bishop O'Connell High School

WEST VIRGINIA **Vincent O'Leary,** Wheeling, Wheeling Central Catholic High School

Finalists are listed by state, name, city and high school.

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Life

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Chimps play fair when it counts

Critics question extent to which apes cooperate

By Bruce Bower

Chimpanzees often share and share alike when cooperating in pairs, suggesting that these apes come close to a human sense of fairness, a controversial new study finds.

Like people, chimps tend to fork over half of a valuable windfall to a comrade in situations where the recipient can choose to accept the deal or turn it down and leave both players with nothing, say psychologist Darby Proctor of Yerkes National Primate Research Center in Lawrenceville, Ga., and her colleagues. And just as people do, chimps turn stingy when supplied with goodies that they can share however they like, the researchers report online January 14 in the *Proceedings of the National Academy of Sciences*.

"Humans and chimpanzees show similar preferences in dividing rewards, suggesting a long evolutionary history to the human sense of fairness," Proctor says.

A controversial new study suggests that chimps possess a sense of fairness similar to that of people.

But psychologist Josep Call of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, considers the new results "far from convincing." In Proctor's experiments, pairs of chimps interacted little with each other and showed no signs of understanding that some offers were unfair and could be rejected, Call says.

In the new study, six adult chimps and 20 children ages 2 to 7 played a modified version of the ultimatum game, a cooperation task often used in experiments with adults. In the tests, a proposer could offer one of two tokens to a receiver. If the receiver accepted the proposer's offer, both players kept their shares. If the receiver rejected the offer, both players got nothing. Accepted tokens got handed to an experimenter in exchange for rewards. One token represented an even split of six banana slices (for the chimps) or of six stickers (for the children). The other token granted the proposer five of six rewards. Pairs also played a game in which receivers had to accept all offers.

Proposers opted for even splits much more frequently when a partner could reject offers. Two pairs of chimps split banana slices equally much more often than expected by chance.

Children playing these games behaved much as chimps did.

In both species, receivers exchanged all tokens for rewards, even those for unfair deals. Neither chimps nor kids were trained that refusal was an option, but the mere threat of a partner's retaliation motivated proposers to share equally, Proctor proposes.

Keith Jensen of the University of Manchester in England disagrees with that conclusion. Receivers' acceptance of all offers "suggests that they were not sensitive to unfairness but were motivated only by getting rewards," he says. That undermines any suggestion that chimp or child proposers assumed that their offers could be rejected.

Corals prepped to take heat

Corals that can survive in warming ocean water may be genetically primed to sweat it out. In reef-building *Acropora hyacinthus* corals (one shown) from American Samoa's Ofu Island, the activity of hundreds of genes changed when both heat-sensitive and heat-tolerant versions of the corals were switched from 29.2° Celsius water to 32.9° water. But even before getting into hot water, the heat-tolerant corals had already turned on 60 genes designed to help combat heat and stress, researchers from the Stanford University Hopkins Marine Station in Pacific Grove, Calif., report online January 7 in the *Proceedings of the National Academy of Sciences.* Sensitive corals that bleach in the heat didn't turn on those heat- and stress-beaters until after temperatures rose. It's not clear if the heat-tolerant corals face long-term consequences from their constant vigilance against environmental stress. The finding could help researchers better predict how future climate change may affect coral populations. —*Tina Hesman Saey*

FROM TOP: D. PROCTOR; FRANCO BANFI/GETTY IMAGES

"There's no shortage of starlings and other birds in cities." —JAMIE CORNELIUS

City lights create sexual early birds

Male blackbirds end up with untimely reproductive surge

By Susan Milius

City lights can deliver male birds into reproductive readiness weeks ahead of schedule.

Male European blackbirds monitored in a lab under simulated city lighting started secreting increased levels of testosterone and growing their sexual organs up to a month earlier in the spring than birds kept in country-style darkness, Davide Dominoni of the Max Planck Institute for Ornithology in Radolfzell, Germany, reported January 6.

Dominoni's colleagues have found that, outside the lab, male blackbirds flying around Munich undergo this growth surge about three weeks earlier than counterparts in a forest just 40 kilometers out of town.

Beginning in December 2010, the researchers exposed captive blackbirds to nighttime light levels they would encounter in urban settings. The team estimated those levels by outfitting free-flying blackbirds with light-sensitive devices and averaging the urban light exposure. A winter of night light in the lab sped up the males' molting and advanced testosterone surges as well as organ development in spring. Continuing the night light treatment through the next winter left the males reproductively shut down in the spring of 2012.

The lab nighttime lights probably kept the birds' seasonal reproductive clocks from resetting at the end of the first breeding season, Dominoni says. That second-year suppression may not be common in the real world, where birds fly around and experience more variety in night lighting, he says. But he sees the lab breeding shutdown as a sign of how big an impact artificial light might have.

"There's no shortage of starlings and other birds in cities," said Jamie Cornelius of the University of California, Davis: Urban birds can reproduce despite artificial lights, and Cornelius says she'd love to know what lets them manage when the lab birds couldn't.

Maybe the results hold a nugget of inspiration for some kind of light-driven control for nuisance birds, said Ned Place of Cornell University. Perhaps blasts of illumination in certain urban places on a certain series of nights could discourage overpopulation by less-beloved avian residents. ■

Male European blackbirds exposed to urban night light levels molted sooner and their sexual development progressed up to a month faster than birds living with dark nights.

DARREN SHILSON/FLICKR

MEETING NOTES

Pregnant male pipefish have hormone swings

The first study to track a form of testosterone through male pregnancy in fish has found an unusual roller coaster of swoops and spikes.

Among pipefishes, seahorses and sea dragons, females produce eggs but males get pregnant, carrying the embryos. Even though pregnant male Gulf pipefish (*Syngnathus scovelli*) reverse common sex roles, tests show males still have more of the main fish form of testosterone (called ketotestosterone) than females do, Sunny K. Scobell of Texas A&M University in College Station reported on January 6. What's different in role-reversed pipefish is that male ketotestosterone levels vary, much as hormones do in females of other species.

For most of a male pipefish's 14-day pregnancy, ketotestosterone concentrations stay low, closer to female ketotestosterone levels. This dip allows for normal embryo development. About day 10 or 11, male ketotestosterone concentrations shoot up tenfold, presumably letting males ready sperm for the next mating, within a day or so of giving birth, Scobell said. —*Susan Milius*

Wings have damage control for insect-sized smash-ups

Flying insects have their fender-benders, too, and so have evolved at least two alternatives to bumpers.

Yellow jacket wings have a dot of rubbery material called resilin toward the wing tip along the leading edge. The wing doesn't flex in flight but bends there during collisions, Andrew Mountcastle of Harvard University reported January 5.

In a lab test, wings with a natural resilin patch lost only 18 percent of the tip area when a yellow jacket was spun in a rotating cradle that bumped the wing tip area against a fixed surface for an hour. When researchers immobilized the rubbery spot (by gluing on a dot of polyester glitter), spinning yellow jackets lost about 80 percent of their wing tip area.

A common bumblebee's wings don't have rubbery spots, but spinning them in the collider didn't cause damage as severe as in yellow jacket wings with a glitter-stiffened joint. Resilin might not help much in bumblebees because it would have to be six times stiffer to prevent flexing during their deep, fast wingbeats, Mountcastle calculated. Instead, he hypothesizes that bumblebees get crash flexibility from reduced wing veins toward the tip. —*Susan Milius*

News in Brief

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MIND & BRAIN

Brain region linked to selfishness

People with damage to a specific part of the brain entrusted unexpectedly large amounts of money to complete strangers. In an investment game played in the lab, three women with damage to a small part of the brain called the basolateral amygdala handed over nearly twice as much money as healthy people. These women didn't expect to make a bunch of money back, an international team of researchers reports online January 22 in the *Proceedings of the National Academy of Sciences*. Nor did they think the person they invested with was particularly trustworthy. When asked why they would invest so generously, the volunteers couldn't provide an answer. The results suggest that normally, the basolateral amygdala helps to enable selfishness. —*Laura Sanders*

ENVIRONMENT

Chemical tied to obesity inherited over multiple generations

Prenatal exposure to a chemical used in PVC and ship paint promotes obesity in mice. And the effect is long-lasting: The mice's grandchildren were also fat despite no exposure to the chemical. The work shows that the effects of an obesogen—a chemical that encourages fat accumulation—can be passed on to unexposed future generations, researchers report online January 15 in *Environmental Health Perspectives*. The compound tributyltin is often added to PVC as a stabilizer and to marine paint as an antifouling agent. Raquel Chamorro-García of the University of California, Irvine and colleagues fed pregnant mice tributyltin at quantities similar to what people might ingest through house dust and other sources. The mice gave birth to pups that developed more and larger fat cells, as well as fattier livers, compared with unexposed pups. These changes appear to be permanent. The children and grandchildren of these mice also had increased amounts of body and liver fat. The findings confirmed previous work showing that tributyltin affects the regulation of body fat production and reprograms certain stem cells to become fat cells rather than bone cells. —*Erin Wayman*

GENES & CELLS

Reprieve for reprogrammed stem cells

What could have been a stumbling block for using reprogrammed stem cells in the clinic may barely be a bump in the road. A study published in 2011 in *Nature* found that stem cells produced by reprogramming mouse skin cells get attacked when transplanted back into mice. Stem cells derived from embryos didn't similarly rile the immune system. The finding was unexpected because reprogrammed stem cells, also known as induced pluripotent stem cells, or iPS cells, come from the mouse or person into whom they are transplanted, so the immune system shouldn't recognize them as foreign. Now Masumi Abe of the Japanese National Institute of Radiological Sciences in Chiba and colleagues have performed a more expansive version of the earlier study, examining 10 different types of iPS cells and seven types of embryonic stem cells to address the potential problem. Neither embryonic stem cells nor iPS cells provoked the immune system to attack to any significant degree when transplanted into mice, the researchers report online January 9 in *Nature*. However, heart muscle cells grown from iPS cells in a lab dish did stir up the immune system, which may be cause for concern. —*Tina Hesman Saey*

Genes indicate Stone Age link between India and Australia

Genetic evidence suggests some people migrated from India to Australia roughly 4,300 years ago, about the same time that new types of stone tools and dingoes arrived on the island continent. Australia is thought to have been mostly isolated from the rest of the world between the arrival of its earliest human inhabitants about 45,000 years ago and its first European settlers during the 18th century. But a study by Mark Stoneking of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, and colleagues suggests that Stone Age Indian immigrants brought their technology and dogs with them to Australia and assimilated into local populations. The finding appears online January 14 in the *Proceedings of the National Academy of Sciences*. —*Tina Hesman Saey*

Genes tied to body mass set point

Genes may help determine why some mice (and perhaps people) become obese when eating a sugar- and fat-laden diet, while others can, to a certain extent, fend off the extra pounds. Working with about 100 types of mice, Aldons Lusis of UCLA and colleagues found that most strains gained weight when fed a high-fat, high-sucrose diet, but stopped gaining weight after a few weeks on the high-calorie diet. Only a few strains continued to pack on body fat over the course of the eight-week experiment. The finding could be evidence of a biological set point for body mass, the researchers report in the Jan. 8 *Cell Metabolism*, with some genetic variants disrupting the mechanism that creates the weight ceiling. The amount of body fat the mice packed on could be traced to 11 different genetic variants, including some implicated in human obesity. —*Tina Hesman Saey*

HUMANS

Ancient human DNA suggests minimal human-Neandertal mating

A 40,000-year-old human skeleton found in China has yielded genetic clues to Stone Age evolution. Ancient DNA indicates that this individual belonged to a population that eventually gave rise to many present-day Asians and

Native Americans, says a team led by Qiaomei Fu and Svante Pääbo, evolutionary geneticists at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. The partial skeleton, unearthed in Tianyuan Cave near Beijing in 2003, carries roughly the same small proportions of Neandertal and Denisovan genes as living Asians do (*SN: 8/25/12, p. 22*), the scientists report online January 22 in the *Proceedings of the National Academy of Sciences*. That result suggests that Stone Age people and their close evolutionary relatives interbred infrequently. —*Bruce Bower*

Wrist bones said to distinguish hobbits from humans

Three hobbit wrist bones unearthed on the Indonesian island of Flores support the contested idea that these half-sized individuals belonged to a species called *Homo floresiensis*, scientists conclude online January 4 in the *Journal of Human Evolution*. The finds, as well as the wrist of a previously reported hobbit skeleton, differ markedly from human wrists, says a team led by anthropologist Caley M. Orr of Stony Brook University in New York. Hobbits' wrists limited their ability to make and use stone tools, the scientists contend. Hobbits died out around 17,000 years ago, after having descended from a member of the human evolutionary family that must have reached Indonesia by 1 million years ago, the researchers propose (*SN: 5/8/10, p. 14*). Other researchers consider hobbits to have been human pygmies. —*Bruce Bower*

SCIENCE & SOCIETY

Cold spells were dark times in Eastern Europe

Some of Eastern Europe's greatest wars and plagues over the last millennium coincided with cold periods, scientists report online January 14 in the *Proceedings of the National Academy of Sciences*. Ulf Büntgen of the Swiss Federal Institute for Forest, Snow and Landscape Research in Birmensdorf and his colleagues reconstructed temperatures using tree rings from 282 living larch trees and 263 construction timbers from historical buildings in northern Slovakia. Because the width of tree rings varies with growing season temperature, the researchers could estimate changes in May and June warmth from 1040 to 2011. The Black Death in the mid-14th century, the Thirty Years' War in the early 17th century, the French invasion of Russia in the early 19th century and other social upheavals occurred during cold spells. The team suggests food shortages could explain the timing of some of these events. —*Erin Wayman*

Until recently, chimps in Tanzania's Gombe Stream National Park only rarely probed trees for carpenter ants.

Group to group

Wild chimpanzees pick up ant-fishing behavior from a female immigrant

By Erin Wayman

Photographer Bill Wallauer was following a group of chimpanzees in Tanzania's Gombe Stream National Park one March day when a young female caught his eye. She had climbed a tree, inserted a thin, peeled branch into a hole and was fishing out carpenter ants. Wallauer, of the Jane Goodall Institute, took out his video camera and filmed the chimp as she slurped up insects for several minutes.

What Wallauer witnessed wasn't supposed to happen. Though chimps in other areas use tools to collect carpenter ants, scientists studying the Kasekela chimp community at Gombe had rarely seen the behavior since Jane Goodall began her fieldwork there in 1960. Before Wallauer's 1994 observation, researchers had seen only one other instance of the behavior, in 1978. This type of tool use was considered a fluke.

But when Robert O'Malley, a primatologist now at Kenyon College in Gambier, Ohio, went to Gombe in the late 2000s, he noticed many of the Kasekela chimps regularly fishing for ants. He wondered why, after decades with only a couple of sporadic sightings, ant probing had become a widespread habit. Because of meticulous record keeping at Gombe, O'Malley and his colleagues had a rare opportunity to reconstruct the origin of this behavior.

An adult female immigrant who joined the Kasekela group in the early 1990s, the team concluded, introduced ant fishing, a common practice in her previous community. The finding, reported late last year in *Current Anthropology*, marks the first time in the more than 50-year history of chimp field studies that anyone has documented the transfer of a cultural tradition from one wild chimp group to another.

"It's something we've been waiting for forever," says William McGrew, a cultural primatologist at the University of Cambridge in England.

Research in captive chimps had suggested that they are capable of cultural exchange, but no one knew whether apes do it naturally. Uncovering and analyzing cultural spread in chimps, humans' closest living relatives, may give scientists a glimpse of what makes human culture special.

Between you and me

Most scientists who study chimps agree that the animals have a basic form of culture. A range of "customs" — everything from meal choices to tool use to courtship rituals — vary from group to group (*SN: 11/17/07, p. 317*). These traditions often arise within a community when one member invents something new and the behavior catches on. Primatologists have recorded many examples of this process. In the 1990s, for instance, a group of chimps in Côte d'Ivoire's Taï National Park started eating the leaves of two plant species in a different way, nibbling a leaf into a crescent shape and then swallowing it whole. (The purpose of this "leaf cutting" is unknown.) And in 2011 Japanese researchers reported that a chimpanzee community in the West African nation of Guinea learned how to disable snares set by hunters.

A first clue that habits might actually pass between groups came from a field experiment reported in 2003. Over a decade, researchers periodically provided wild chimps in Guinea with piles of hard-shelled coula nuts in a forest clearing. The chimps knew how to use stones as hammers but were unfamiliar with these nuts. A 30-year-old female immigrant started smashing the new nuts right away. Eventually, other individuals followed. By the end of the study, about two-thirds of the chimps cracked coula nuts whenever the researchers offered some. The scientists suspect that the pioneering immigrant recognized coula nuts as edible because she came from a group that regularly dined on them.

The new study offers more persuasive proof of natural cultural exchange and is the only documented case among chimps involving no human intervention. Like a historian piecing together the past, O'Malley combed through Gombe's records, including some of Jane Goodall's original notes, to look for instances of ant fishing. He also watched videos taken by Wallauer in the 1990s and 2000s and collected his own observations from 2008 to 2010.

The Gombe files, along with interviews

R.C. O'MALLEY

with long-term field assistants, confirmed that Wallauer's 1994 encounter was the first time since 1978 that researchers had watched Kasekela chimps fish for ants. From 1994 through 2007, ant fishing was observed 11 additional times. The activity became even more frequent after 2008, when O'Malley witnessed 17 sessions of one or more chimps probing trees for carpenter ants. By 2010, all chimps born in Kasekela after 1981 were ant fishers, as were several females who moved into the community as adults.

Circumstantial evidence points to a female named Trezia as Kasekela's original ant fisher: She was the first adult to proficiently probe for carpenter ants and the only adult before 2003 to eat the insects. Trezia moved to Kasekela in 1991, coming from the neighboring Mitumba group. Researchers had documented frequent ant fishing in Mitumba since the late 1980s, so Trezia probably knew how to probe for ants before she joined the Kasekela group. Once she became established in the community, young chimpanzees picked up her habit, passing it along to new generations.

"The whole pattern fits that it was introduced by another group," says psychologist Andrew Whiten of the University of St. Andrews in Scotland. If so, ant fishing at Gombe offers the best evidence yet that chimps do swap traditions.

But Bennett Galef, an animal behaviorist at McMaster University in Hamilton, Canada, is skeptical that ant fishing at Gombe counts as an example of a cultural swap. Kasekela chimps already fished for termites, so it is not surprising that they started using the same technology on a new insect, he notes. "It really isn't a transfer of a novel behavior."

Rare and elusive

The fact that it took more than half a century to identify a possible instance of cultural transmission among any wild chimp groups raises the question of whether such an event is rare or simply difficult to document. The answer is probably both.

Studies in captivity and in the wild hint that cultural transmission across groups may be an unusual phenomenon. Though young chimps learn at least in part from watching their peers, adults don't like to try new things. "They're creatures of habit," Whiten says. "Like humans, they get stuck in their ways." Even innovations within a group rarely take hold. This may explain why adventurous youngsters took up ant fishing at Kasekela while older adults never bothered.

Migrations in general are uncommon — maybe two individuals will enter a group each year at Taï, for example — which also limits the chance for cultural exchange, says primatologist Christophe Boesch of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. Because chimps tend to be conformists, newcomers usually adopt the traditions of their new group, he says. A recent experiment in captive chimps supports this claim. When presented with equally viable ways to solve a novel task, chimps at a sanctuary in the Republic of the Congo chose the method used by the most other chimps, researchers reported last year in *Current Biology*.

Prestige plays a role in learning, too. Just as teenage boys and girls copy Justin Bieber's haircut or Taylor Swift's sense of style, chimpanzees emulate high-ranking group mates. Because immigrants — always female since males don't leave the group where they are born — have low status, chimps don't normally pay attention to what they do. But Trezia rose through the ranks quickly, making her an attractive role model, O'Malley says.

Local environmental conditions at Gombe also helped ant fishing spread. Kasekela's territory is home to a frequently visited spot that has several trees well stocked with carpenter ants, where multiple chimps can probe for the bugs simultaneously. Sparse ground vegetation makes it easy for the chimps to watch and learn from each other.

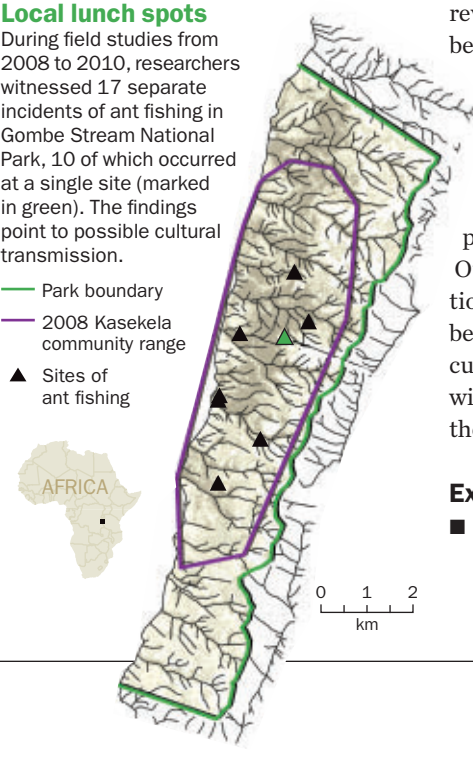
The introduction of ant fishing at Gombe underscores the social, psychological and ecological factors behind cultural transmission. But no matter how common or rare such swaps may be, they will always be hard to detect, O'Malley says. Researchers can't observe all group members all the time, so key events may be missed. And to identify knowledge transfers between groups, scientists need to know the behavioral repertoires of multiple local communities. Gombe is one of the few field sites where more than one chimp group is monitored, he says.

Despite the difficulties, collecting more examples of cultural exchange may help reveal what behaviors are most likely to be traded, as well as when, why and how.

But time may be running out. Deforestation and hunting threaten the ape's long-term survival. "Many communities have already disappeared and have taken their unique patterns of behavior with them," O'Malley says. "As remaining populations become more isolated, there will be fewer opportunities for gene flow and cultural diffusion." For scientists that will mean fewer opportunities to witness these events. ■

Local lunch spots

During field studies from 2008 to 2010, researchers witnessed 17 separate incidents of ant fishing in Gombe Stream National Park, 10 of which occurred at a single site (marked in green). The findings point to possible cultural transmission.



Explore more

- Christophe Boesch. *Wild Cultures: A Comparison Between Chimpanzee and Human Cultures*. Cambridge Univ. Press, 2012.

R.C. O'MALLEY *ET AL*/*CURRENT ANTHROPOLOGY* 2012

Urban eyes

Too much time spent indoors may be behind a surge in nearsightedness

By Nathan Seppa

Rogers Hornsby, one of the best hitters ever to swing a baseball bat, had a reputation for being standoffish. Teammates complained that he didn't socialize, even balking at attending movies — prime entertainment during the 1920s. Sitting in a dark theater watching a bright screen made it difficult to hit a baseball, Hornsby used to say. Hard to argue with a guy who reportedly had terrific eyesight and who finished three seasons with a batting average better than .400.

95 percent

Portion of young men in Seoul who are nearsighted

Hornsby might have been onto something that scientists are only now coming to embrace: Too much time spent indoors may contribute to nearsightedness, also called myopia.

Nearsightedness has increased steadily in North America and Europe in recent decades, with one-third of adults in the United States now nearsighted. That figure alone is cause for concern. But the rise of myopia in East Asia is downright alarming. Recent studies of young men in Seoul and college students in Shanghai find that more than 95 percent are nearsighted. Increases also have shown up across other urban centers in the Far East.

Studies first uncovered a link between myopia and limited outdoor time during childhood just a few years ago. At the time, many researchers were taken aback. The notion that child's play might promote normal eye growth seemed almost magical.

"Certainly, before five years ago, I don't think anybody had taken much notice of how much time people spent outdoors," says Jeremy Guggenheim, an optometrist who has researched myopia in Wales and is currently at Hong Kong Polytechnic University. He believes the findings offer a "new and exciting direction" for research.

It's tantalizing to think that time spent outdoors early in life might fend off the need for eyeglasses, contact lenses or laser surgery in many people. But, Guggenheim notes, it is not yet clear to what extent outdoor exposure can cut risk or how it does so. Some scientists say the benefit could come from exposure to natural light, a relaxation of the eye gained from viewing things at a distance or the visual tableau that reaches the eyes' peripheries while outdoors. Or it could be a mix of all those factors.

"There are great open questions, and that keeps us from making strong recommendations," says Donald Mutti, an optometrist at Ohio State University College of Optometry in Columbus.

Aside from spending time outdoors, a person's other behaviors might matter too. The higher myopia rates documented today coincide with a whole generation of children raised on computers, video games and, especially in the Far East, intense pressure to achieve in school. Some researchers cite a long-debated theory linking myopia to excessive reading or other "near work."

The issue is far from settled. But in Guangzhou, China, a clinical trial of nearsightedness is under way in which some children have been randomly

JOEY CELIS/GETTY IMAGES

E. FELICIANO

assigned to spend an extra hour outside at school each day. The strategy is showing a slight benefit as the data trickle in.

Lots of myopia

The human eye is quite possibly the most fine-tuned organ in the body. In someone with 20/20 vision, the eyes adapt effortlessly to the task at hand. To see a nearby object, eye muscles controlling the lens constrict, focusing an image of the object on the retina at the back of the eye. People with good vision can also see faraway images clearly, because the eye muscles relax and the lens changes shape accordingly. Distant images thus land in focus on the retina.

But people with myopia have a slightly elongated eyeball, which means trouble. Their eyes can still focus images of nearby objects. But more distant images arrive slightly in front of the retina, so they end up fuzzy.

The eye's shape depends on growth that occurs primarily during infancy, and to a lesser extent through adolescence. That growth is ruled in large part by genetic instructions that humans have evolved over many millennia; if the genetic blueprint is defective, eyesight can certainly suffer. But growth of the eye also depends heavily on external cues — what scientists call visual feedback. The bombardment of light, with its colors and contrasts, helps guide proper eye growth.

Scientists are now convinced that something about this external input has changed in recent decades, and those changes are driving the onslaught of nearsightedness seen in teens and young adults.

From the early 1970s to the turn of the century, myopia prevalence in the United States rose from 25 percent to nearly 42 percent among people ages 12 to 54, a substantial shift in just one generation. The rate among U.S. young adults is 38 percent, up from 28 percent in the 1970s. On the other side of the globe, myopia rates in Singapore, which has gone from a sleepy port city to a center for international commerce, have risen from 43 percent among military conscripts (all young men) in the late 1980s to more than 80 percent today.

Meanwhile, older generations haven't experienced a sharp rise in the disorder. The rate in people over age 40 in China and the United States is at about one-fourth.

Because such increases also have not shown up in rural areas, scientists think the trend reflects new behaviors among young urbanites. With more people moving to cities, the trend is likely to worsen.

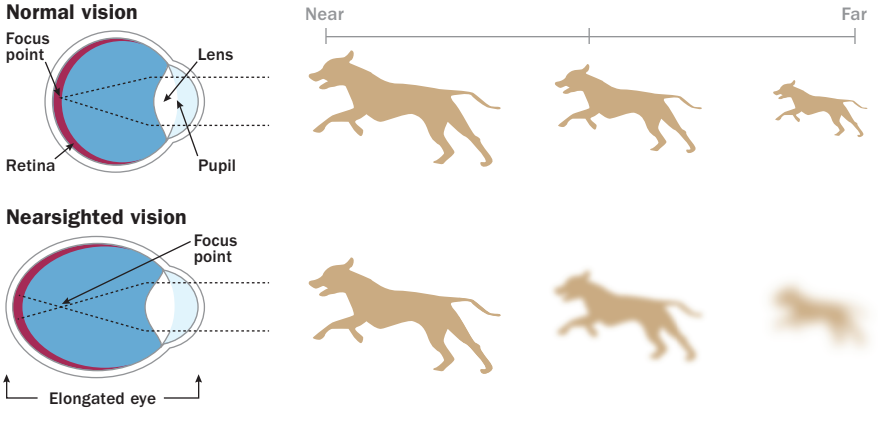
For some, nearsightedness will be a mere inconvenience. But others, who develop high-degree myopia, will have worsening vision over time and a greater risk of cataracts, glaucoma or a detached retina later in life. Of those young men in Seoul and students in Shanghai who are nearsighted, roughly one in five already has high-degree myopia.

"There will be an epidemic of pathological myopia and associated blindness in the next few decades in Asia," says Seang-Mei Saw, a physician and epidemiologist at the National University of Singapore.

The uptick in nearsightedness in recent decades prompted scientists to hunt for a cause, bringing the link between myopia and outdoor exposure into sharp relief. In 2007, Mutti and his Ohio State team identified 514 children who were not nearsighted in the third grade and analyzed differences among the kids up to five years later. By then, one-fifth of them had developed myopia. Even after accounting for any parental nearsightedness, the team found that kids who had spent more time outdoors doing physical activity were less likely to become nearsighted than were children who got out less. The report appeared in *Investigative Ophthalmology & Visual Science*.

In 2008, Ian Morgan of the Australian National University in Canberra

Ocular sweet spot In someone with 20/20 vision, the lens focuses images neatly on the retina. Both near and far objects are clear. But in people with myopia, the eye is elongated, so distant images converge somewhere in front of the retina. These images appear blurry.



and Kathryn Rose of the University of Sydney also reported a link to outdoor exposure. Preteens who spent ample time outside — at leisure or sports — were less apt to develop myopia. Writing in *Ophthalmology*, the Australians noted that playing indoor sports didn't seem to have the same effect. What's more, the researchers didn't find clear evidence of harm from near work. Simply being outside mattered. Subsequent studies in China, Singapore and the United States have bolstered these results.

The reports represent a departure in thinking from a few decades ago, when many in the field assumed myopia was mainly a hereditary problem. After all, having one nearsighted parent lends some risk of needing glasses, and having two imparts more.

But scientists searching for a genetic smoking gun haven't found one. Reporting in *Nature Genetics* in 2010 and in *Human Genetics* last year, two international teams identified many variant forms of genes that showed up more often in nearsighted people. But, says Guggenheim, "These are subtle genetic effects that explain only a small proportion of myopia." What's more, work comparing Chinese children living in different environments and with different outdoor exposures suggests that genetic similarities linked to ethnicity can be trumped by daily behavior.

The new wave isn't genetic, Morgan says. "The gene pool can't change that much in a generation, not even in several," he says. "We've now got a very convincing new factor, and that's time spent outdoors."

Into the light

While nearsightedness remains incompletely understood at the molecular level, what scientists have figured out supports the outdoor-light explanation. Laboratory work shows that bright light stimulates the release of the neurotransmitter dopamine in the retina, which limits unwanted eye growth.

Eye growth is a delicate balance influenced by dozens of natural chemicals, and light is part of it, says William Stell, a physician and neurobiologist at the University of Calgary in Canada. He likens the process to a car cresting a big hill, poised to zoom down unless the driver steps on the brakes. Dopamine and other stop signals on growth provide those brakes, and exposure to bright light turns on dopamine. A proper balance of homegrown chemicals in the eye, Stell says, "controls whether the car inches forward or plummets."

Compared with daylight exposure, signals from indoor lighting may not slam on the brakes of growth quite as well. A sunny day delivers 28,000 to 130,000 lux, a measure of light intensity. The average house scores less than 1,000 lux.

Tests in animals strengthen the light link. Scientists can induce myopia in animals by strapping on goggles that blur or distort vision. Exposing chicks to sunlight or bright lights in the lab stopped such myopia development, biophysicist Frank Schaeffel of the University of Tübingen in Germany and colleagues reported in 2009. Working with goggled infant rhesus monkeys, researchers at the University of Houston reported similar results last year in *Investigative Ophthalmology & Visual Science*. Both findings lend credence to the outdoor-light theory.

But while the research community broadly agrees that good light and unimpeded vision regulate proper eye growth, questions remain. Animal work doesn't precisely mimic the experience of children. While a distorted visual field can trigger myopia in chicks, simply living under indoor lighting doesn't, Stell says. Millions of people, after all, develop myopia without wearing goggles. Though the outdoor-light theory stands as a strong finding at the population level, it lacks a full explanation. "We really haven't identified the exact goodness of being outdoors," Mutti says.

Apart from providing daylight, being outdoors presents a broad field of vision quite different from being indoors. Andy Fischer, a retinal neurobiologist at Ohio State, notes that the eye is in a more relaxed position in the outdoors. "It's not working to bend the light," he says. That relaxation may shut off growth signals that can distort the eye's shape.

Outdoor exposure also provides a different set of peripheral images, those seen out of the corner of the eye, than does indoor viewing. Although images in the periphery are not at the center of vision, they can be in or out of focus. "If you are outdoors and look into the distance," Schaeffel says, "the focus in the periphery is pretty homogenous." That is, images entering via the periphery of the eye are broadly similar in distance and more apt to be in focus. But indoors, he says, there's a mix of focused and unfocused images.

Animals wearing goggles that distort or block peripheral vision, but not objects at the center of vision, show the type of stimulation in eye growth associated with myopia.

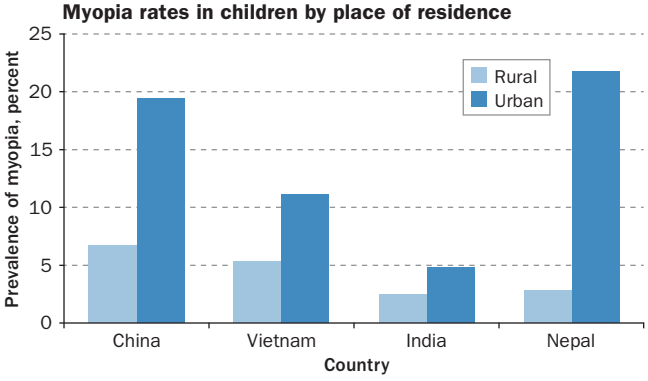
"We used to think that only the center of the eye was, in major part, responsible for eye growth," says Debora Nickla, a biologist at the New England College of Optometry in Boston. Now scientists realize that may not be the case.

Being outdoors also approximates prehistoric humans' visual demands.

Home risk

Studies suggest that rates of nearsightedness differ in ethnically related populations living in rural versus urban areas (data from country to country may not be comparable). City living appears to have a detrimental effect on eye development.

SOURCE: I. MORGAN AND K. ROSE/*PROGRESS IN RETINAL AND EYE RESEARCH* 2005



Throughout evolution, Fischer says, humans spent almost all their time outdoors. New behavior patterns — living in an industrialized society and spending more time in classrooms — place unnatural demands on the eyes that may not mesh well with humans' ancient programming, he says.

Getting close

The other behavioral change that may not mesh well is near work. Human forebears didn't read, and even those who chipped arrow points or did other fine work probably didn't do it all day, every day. Frequent near work arrived with civilization; in many societies, it came about in the last century or two. A lot of myopia develops during childhood, and there may be some science behind the stereotypical bookworm with thick glasses. Myopia can also show up in adulthood, though, with textile workers and microscopists facing high rates of occupational myopia.

Recent work by Saw and others has linked less outdoor exposure and more near work to myopia. "Reading, writing and computer work contribute to myopia," Saw says. "We found that children who regularly spend time on computers have a higher risk of myopia."

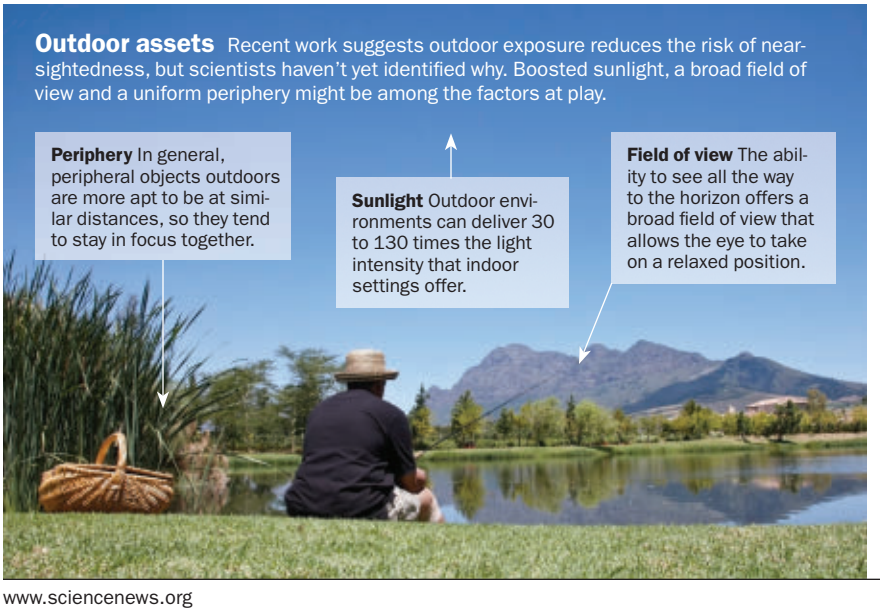
Guggenheim has also found more nearsightedness among youths who read for pleasure, as did a team studying Danish medical students who were engrossed in lots of less pleasurable reading.

The near work explanation lost some adherents when the studies by Mutti and Morgan found little or no harm from it. But the vagaries in sorting out potential myopia triggers are obvious: Someone who reads a lot probably does it indoors; same with watching television or sitting at a computer.

The theories blurred further in a 2007 study of Turkish medical school students. Those with myopia had spent less time outdoors years earlier, up to age 7, than their 20/20 colleagues. And about one in seven of those with myopia had developed it after age 18. The researchers didn't see a difference from near work — everyone had plenty of that — but the finding suggests that the consequences of less outdoor exposure can play out later in life.

Other studies hint at less-explored factors. Physical activity seems to protect 11-year-olds somewhat from myopia, a study found. That trend also showed up in the Danish medical students.

Mutti wonders whether the outdoor effect may also relate to vitamin D, since humans make the vitamin using ultraviolet rays (*SN: 7/16/11, p. 22*). His small study in teens and young adults who spent roughly equal time outdoors found that those with myopia indeed had about 20 percent lower vitamin D levels than those without myopia, even after adjusting for differences in age and diet.



Outdoor assets Recent work suggests outdoor exposure reduces the risk of nearsightedness, but scientists haven't yet identified why. Boosted sunlight, a broad field of view and a uniform periphery might be among the factors at play.

TIRC83/ISTOCKPHOTO

Cultural clash

As these theories get vetted, some scientists are already encouraging action. "We need to get the message out to parents," Stell says. "Kick the kids outside."

Morgan agrees, but says cultural expectations might block the way in some of the countries where myopia rates are already soaring. "It's just stunning how strongly organized the life of a Chinese child is toward study," he says. In school, children nap indoors for an hour or two at lunchtime, resting up to do hours of homework later. It would be hard to change this pattern, he says. "When I floated the idea of stopping naps at lunchtime in China, the response was almost like I was advocating child cruelty." Western kids may work hard, Morgan says, "but you ain't seen nothing until you've seen China."

Even so, getting children outdoors might be easier than cutting back on near work, Saw says. Asian educational systems have reached a "saturation point" of intensity and competition, she says, "but it's not a politically correct message to tell children to read or work less."

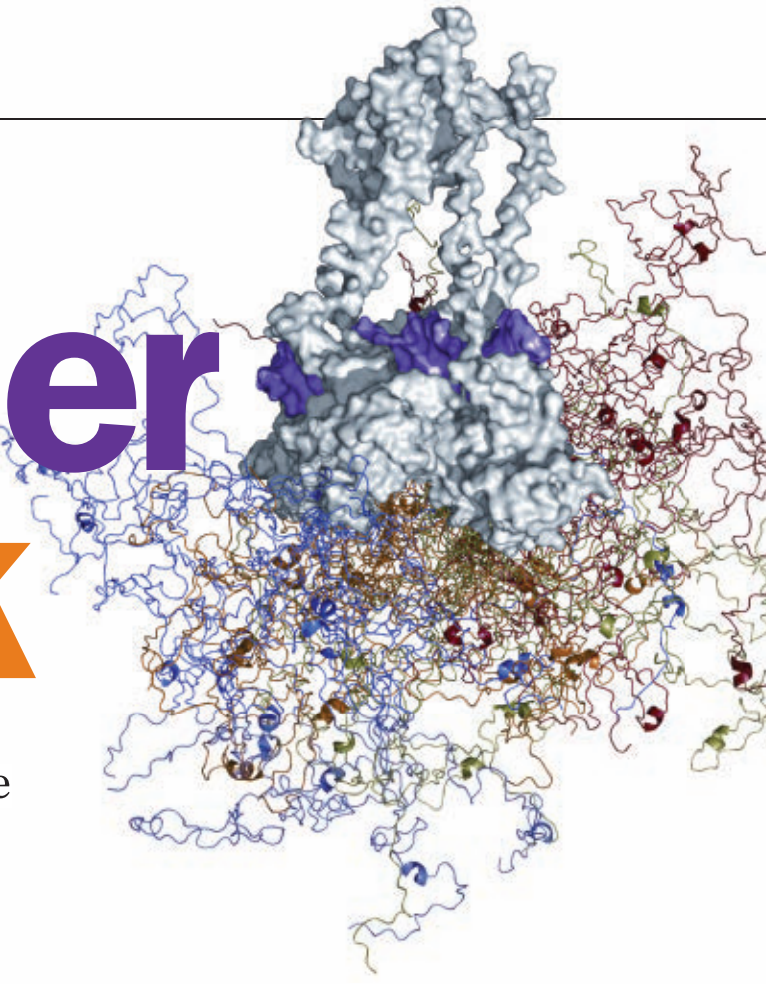
In the United States, the clinical response to these new data has been uneven. While eye doctors are becoming aware of the outdoor-light theory, many don't see a child until after the kid has failed an eye exam at school, says psychologist Jane Gwiazda of the New England College of Optometry. Gwiazda says pediatricians are the ones who might be able to encourage outdoor time before it is too late. "Once a child is nearsighted," she says, "sending them outdoors to play may not stop the process."

Short of getting out, maybe gazing out would help. It didn't seem to hurt baseball player Hornsby, who was once asked what he did all winter during the off-season. "I'll tell you what I do," he snapped. "I stare out the window and wait for spring." ■

Explore more

- More on myopia and other eye disorders from the National Eye Institute: www.nei.nih.gov

Disorder at Work



Proteins without a definite shape can still take on important jobs

By Tanya Lewis

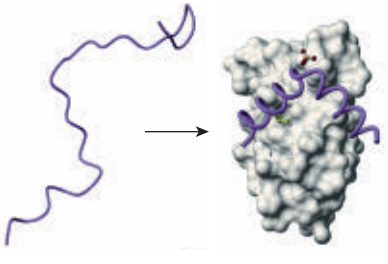
In its unbound state, some parts of the p53 protein take on a definite structure (gray model) while other regions remain flexible and disordered (other colors).

Richard Kriwacki refused to give up on his protein. He had tried again and again to determine its three-dimensional shape, but in every experiment, the protein looked no more structured than a piece of cooked spaghetti.

Normally, this lack of form would be a sign that the protein had been destroyed, yet Kriwacki knew for a fact it could still do its job in controlling cell division. While discussing the conundrum with his adviser in the atrium of their La Jolla, Calif., lab, insight dawned: Maybe the floppy protein didn't take shape until it attached to another protein. Kriwacki raced off to do yet another experiment, this time combining his protein, p21, with a partner. Sure enough, Kriwacki got what he was looking for. Once joined, a seemingly ruined mess gave way to a neatly folded structure. The finding defied a foundational dogma of biology, that structure determines function.

Nearly everything the human body does, from shuttling oxygen through the bloodstream to digesting a meal, relies on proteins. These biological workhorses are composed of chains of molecules called amino acids. Whenever a chain is made, conventional scientific wisdom says, electrical forces cause it to immediately bend into helical ribbons and tight zigzags, which twist further into even more defined three-dimensional forms. The resulting shape determines what other molecular players the protein can bind to and thus what it can accomplish in a cell. Unfolded proteins were thought to result only from intolerable conditions that render a protein useless, such as extreme heat or acidity.

Some disordered protein regions, such as the one below (in purple), take shape once they meet up with another protein (gray).



But since around the time of Kriwacki's discovery more than 15 years ago, disorder has surfaced as a key player in the protein world. "Intrinsically disordered proteins," or IDPs, turn out to play vital parts in controlling cellular processes. More than one-third of all human proteins, in fact, may be partially or completely disordered in structure, floating around like strands of wet noodles. "The roles that disordered regions can play are quite diverse," says Kriwacki, now at St. Jude Children's Research Hospital in Memphis, Tenn.

To better understand how something so flexible can be functional, researchers are now taking a closer look at how the disordered proteins interact with other proteins. The disordered dissidents can behave as switches, quickly turning cellular processes on or off in

FROM TOP: P. TOMPA/*TRENDS IN BIOCHEMICAL SCIENCES* 2012; H.J. DYSON AND P.E. WRIGHT/*NATURE REVIEWS MOLECULAR CELL BIOLOGY* 2005

response to changing conditions, or as shape-shifting ensembles that integrate multiple signals before telling a cell to get a job done. Studying the interactions of intrinsically disordered proteins may even yield insight into certain diseases and lead to new treatments.

Floppiness exposed

Disordered proteins flew under the radar for so long because the standard technique for determining a protein's structure, known as X-ray crystallography, requires that the protein retain a set shape long enough to be crystallized. Scientists had found a few examples of proteins that couldn't be crystallized, but these were thought to be anomalies.

When Kriwacki encountered the troublesome p21 protein, he was working with molecular biologists Jane Dyson and Peter Wright at the Scripps Research Institute. Dyson and Wright were using a technique called nuclear magnetic resonance, or NMR, spectroscopy, which reveals a molecule's form based on the magnetic properties of its atoms' nuclei as opposed to its crystal structure. "Peter and Jane's lab at the time was the world-leading protein NMR lab," says Kriwacki. Advances in NMR were what allowed him to finally figure out what his protein looked like.

After p21, examples of these proteins just kept turning up. You don't need to go looking for them, Dyson says, "they'll come looking for you, believe me." In 1999, Dyson and Wright published a landmark review paper in the *Journal of Molecular Biology* that set the stage for a new protein paradigm. There were too many examples to be mere outliers; it was clear that something bigger was going on. "We were finding that these proteins were not only unstructured, but had to be," Dyson says.

33 percent

Estimated portion of all eukaryotic proteins with large disordered regions

35 percent

Estimated portion of human proteins containing large disordered regions

Meanwhile, other scientists were independently building a strong case for the existence of intrinsically disordered proteins. Keith Dunker, a bioinformatician at Indiana University School of Medicine in Indianapolis, and Peter Tompa, a protein chemist at the Free University of Brussels, were both leading efforts to predict disorder mathematically. "The main thing we did was to determine that unstructured proteins have a fundamentally different amino acid composition compared to structured proteins," Dunker says.

A protein's mix of amino acids can create regions that are either hydrophilic ("water-loving") or hydrophobic ("water-hating"). Structured proteins that exist in solution typically fold into spherical shapes with a hydrophilic shell enclosing a hydrophobic core. But disordered proteins contain few, if any, hydrophobic regions, so they don't fold up. They also tend to have more electrically charged portions. "If you look at these differences, you can anticipate that they're not going to fold into a 3-D structure," Dunker says. To help study the differences, he and his colleagues developed "DisProt," a database of proteins that experiments have shown to be disordered.

Though scientists often speak of "structured proteins" and "intrinsically disordered proteins" as if they are distinct classes, along the way it has become clear that any particular protein's degree of disorder falls on a spectrum, from precise rigidity to complete disarray. Proteins can also migrate along that spectrum from one moment to another, shifting into different versions of themselves. Many disordered proteins, including p21, eschew their wiggly nature when binding to a partner protein — like a string puppet snapping to attention. Others fold to a more limited extent upon binding, and some never shape up at all.

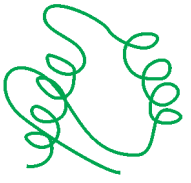
Fold for a cause

How a protein's degree of disorder enables its function is now a hot topic of research. Ongoing efforts suggest some disordered proteins act like switches, triggering or stopping an action in response to a signal. This makes them well-suited for controlling activities such as the production of other proteins, cell growth or division, and the sending of cellular signals.

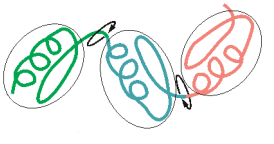
Lately, Dyson has been working with Elizabeth Komives of the University of California, San Diego to study a duo of proteins, NF-kappaB and I-kappa-B-alpha. Together, the proteins control a

Structure spectrum Choosing to label a protein as disordered or ordered is not always straightforward. Some proteins are as wiggly as cooked spaghetti, while others can be mostly structured with just a few regions that dabble in disorder.

Unstructured This is the most disordered state. Proteins at this end of the spectrum do not take on any fixed 3-D shape.



Molten globule In this state, a protein shows some sense of shape, but it is very loose. It is as if the protein were caught halfway through its folding.



Linked folded domains Like beads on a string, well-shaped protein portions are connected by unstructured and more flexible regions.

Mostly folded, local disorder Some highly structured proteins still contain short sequences of amino acids that eschew any folded form.

H.J. DYSON AND P.E. WRIGHT/*NATURE REVIEWS MOLECULAR CELL BIOLOGY* 2005

host of vital phenomena in cells, from growth and development to immunity and stress response. The proteins, which both contain disordered regions, normally exist bound together as a complex within a cell. When the cell receives a signal, such as a hormone molecule binding to its surface, IκBα is tagged for destruction and degraded. NFκB is released and sent to the nucleus. There, NFκB binds to the DNA, turning on genes that hold the instructions for making specific proteins.

One of the proteins produced is more IκBα, which allows the response to be switched off again when it is no longer needed. IκBα binds to NFκB and strips it from the DNA, Dyson and Komives reported last year in *IUBMB Life*. It's not yet clear how the stripping process works, but the disordered regions of IκBα appear to cast around like a fishing line to find NFκB and peel it off the DNA. The new complex of NFκB and IκBα leaves the nucleus and returns to its resting state within the cell. Thanks in part to the disordered regions, the cell can respond flexibly and rapidly to external stimuli.

Thanks in part to the disordered regions, the cell can respond flexibly and rapidly to external stimuli.

While NFκB and IκBα become mostly structured upon binding, other IDPs remain highly dynamic. One example is Sic1, a disordered protein found in yeast that prevents DNA replication and thus keeps cells from dividing. A 2008 study led by Julie Forman-Kay of the University of Toronto and then-colleague Tanja Mittag revealed how proteins such as Sic1 function as "dynamic ensembles" of disordered states. Sic1 contains six short disordered regions that take turns binding in a "pocket" of a partner protein. At any given moment, only one of Sic1's six regions sits inside the pocket, while the other regions remain disordered. Each of these six regions is susceptible to modifications that can deactivate it in a way that prevents it from binding. All six of them must be ready to bind for Sic1 to hold onto its protein partner and stave off cell division. Each segment's activation is like a weight added to one side of a balance — only with enough weights does the scale tip.

While some disordered regions play active roles in sensitive responses, others serve only to hold more structured areas together like beads on a string. The disordered protein complex CBP/p300 has several structured regions connected by long, floppy "flexible linkers." The linkers form a malleable scaffold for bringing together the structured parts of the protein complex, controlling how and when these other players interact.

In sickness and health

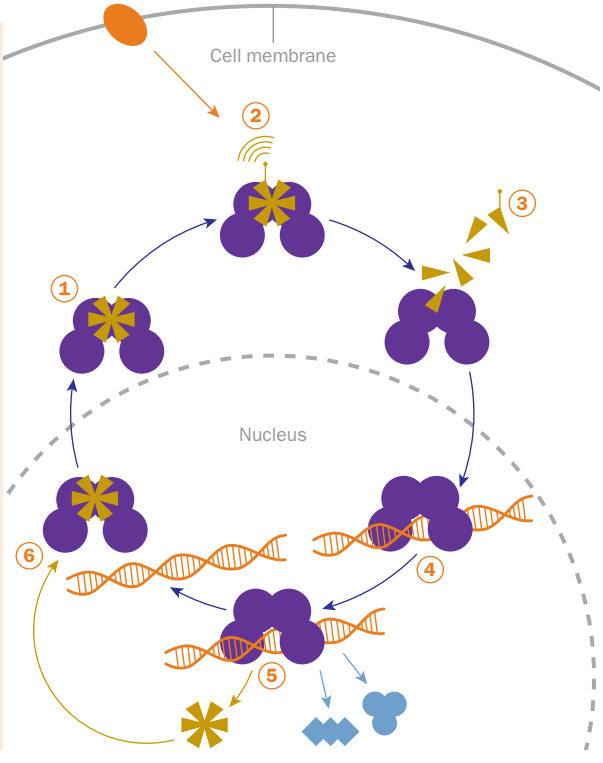
Historically, before IDPs took off, anything other than a properly structured protein was considered a disease risk. This was a reasonable conclusion, given that diseases often result when proteins take forms they aren't meant to, a process called misfolding. Today, though, scientists know that a disordered protein is not the same as a misfolded one.

Still, IDPs, like any proteins, can misfold. And misfolded proteins known to play roles in some high-profile diseases have recently turned out to be disordered. The tau protein, for example, forms the characteristic protein tangles seen in Alzheimer's disease. Same, it seems, for alpha-synuclein and Parkinson's disease. Some scientists think disordered proteins may be more prone to misfolding than other types, but the relationship is not yet clear. By understanding the full range of protein folding behavior, scientists hope to gain insight into the causes of such diseases.

Homing in on interactions involving disordered proteins could also lead to new approaches to treatment. Drug developers have traditionally focused on creating molecules that bind to highly structured proteins that carry out reactions in a cell. That means binding to what's called an "active site." But the

Protein power Because of its disorder, a protein known as IκBα can act as a switch that turns a host of cellular behaviors on and off. It's IκBα's interaction with another disordered protein, NFκB, that makes this regulatory role possible.

SOURCE: H.J. DYSON AND E.A. KOMIVES/*IUBMB LIFE* 2012



1 IκBα (gold) and NFκB (purple) bind together to form a complex inside the cell.

2 A signal from outside the cell can tag IκBα for destruction.

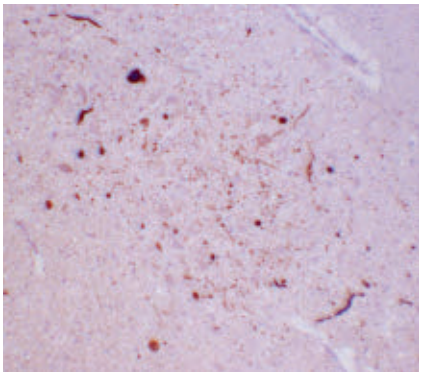
3 IκBα's is rapidly degraded, a process aided by local disorder.

4 No longer attached to IκBα, NFκB can enter the nucleus, bind to DNA and turn on genes to trigger protein production.

5 The proteins produced play a host of cellular roles. Included among the proteins is more IκBα.

6 Newly synthesized IκBα locates the DNA-bound NFκB. Disordered regions promote its removal from the DNA, thus turning off signal-responsive protein synthesis. The complex exits the nucleus.

S. EGTS



Alpha-synuclein, a protein implicated in Parkinson's disease (spots show abnormal clumping in brain stem), may be disordered in its healthy state.

new understanding of IDPs opens possibilities for designing drugs that instead interfere with protein-protein interactions, by binding to intrinsically disordered proteins or binding to a site on a partner protein where the IDP attaches.

"The idea of targeting disordered proteins themselves remains very challenging," Kriwacki says. "Much more feasible is to target binding sites on folded [partner] proteins." If a short sequence of a disordered protein is known to bind to another protein that triggers a disease state, a small molecule could mimic that sequence, binding to the partner protein and deactivating it. An anticancer drug developed by the pharmaceutical company Roche is made from Nutlin-3a, a chemical that works in just this way. Nutlin-3a prevents an IDP commonly associated with cancer, p53, from interacting with its partner protein.

Of course, scientists' current understanding of disordered proteins assumes that the versions studied in lab dishes are in fact disordered in cells, a notion some researchers challenge.

Disorder doubters

As with any paradigm shift, the idea that proteins can be disordered but still functional has its skeptics. "I think the majority of people accept disorder," says Wright, "but there are still a few critics." Most studies of IDPs are conducted in lab dishes rather than in living cells, because today's techniques, for the most part, aren't sensitive enough to allow the study of proteins at the low amounts present in actual cells. Scientists commonly use bacterial cells to create many copies of a protein. The protein is then isolated and studied under artificial conditions. This has led some researchers to question whether the apparently disordered state of IDPs is merely an artifact of the lab environment. In the true setting of a cell, which is much more crowded with other molecules, the proteins might be folded, the critics argue.

Neuroscientist Dennis Selkoe of Harvard Medical School and colleagues published a controversial paper in 2011 suggesting that alpha-synuclein protein, widely believed to be disordered in its healthy form, actually exists in a structured state inside cells. Selkoe's team studied alpha-synuclein obtained from human brain cells grown in a lab dish, reporting that the protein appears to occur naturally as a helix-shaped "tetramer" of four proteins as opposed to a single, unstructured protein.

But the findings are highly contested, and others have failed to replicate them. Philipp Selenko, a biochemist at the Leibniz Institute of Molecular Pharmacology in Berlin, used NMR to show that alpha-synuclein was unstructured inside intact *E. coli* bacteria. Biologist Guy Lippens of Lille University of Science and Technology in France and colleagues have shown that tau protein, too, appears unstructured in immature frog egg cells. Still, says Lippens, the question of whether all lab-studied IDPs are truly disordered in cells remains open.

Assuming the proteins are unstructured, another mystery is how they evade degradation. Cells have machinery that recognizes proteins that haven't folded properly and digests them. One theory posits that since IDPs lack regions of the type the degradation system recognizes, the disordered proteins appear to the cell as folded proteins. Another theory holds that "chaperone" proteins bind to IDPs to stabilize them so they don't get eaten up by the cell. A third theory suggests that IDPs are tightly regulated and kept at low levels in the cell, broken down when they are not needed. Studying proteins under natural conditions — in cells — will help provide the answer.

Despite a growing awareness of disorder in proteins, much more research remains to be done. In this chaotic new view of the protein world, scientists must reexamine everything they have assumed about structure and function. "Just like in physics," Tompa says, "the protein universe seems to have this dark matter we have neglected, which now turns out to be important in cells." ■

Loose jobs

Intrinsically disordered proteins, or IDPs, have important regulatory and signaling jobs in cells (some outlined below). Their disorder is thought to make them better at these tasks, by enabling quick and flexible responses to the changing conditions that cells face.

- **Cell cycle activities** Disordered proteins help control when and how a cell grows and divides.
- **Transcription** These proteins turn on and off the copying of genes (DNA) into protein-making instructions (RNA).
- **Translation** IDPs are involved in the reading of RNA to make proteins.
- **Signal transduction** The flexibility of intrinsically disordered proteins allows them to convert a signal coming from outside the cell into a response that shows up within the cell.
- **Self-assembly of multiprotein complexes** IDPs help bring together different proteins to form larger structures — such as the ribosome, a molecular machine that serves as the site of protein synthesis.
- **Cargo transport** These proteins play a role in moving large molecules around a cell along the fibers making up the cell's skeleton.
- **Apoptosis** Disordered proteins can mediate a cell suicide pathway.

Explore more

- M.M. Babu, R.W. Kriwacki and R.V. Pappu. "Versatility from Protein Disorder." *Science*. September 21, 2012.

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The World Until Yesterday

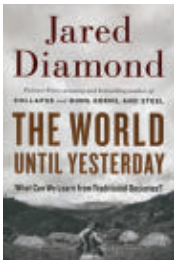
Jared Diamond

While traditional peoples linger at the outskirts of modern society as curious exceptions, Jared Diamond makes a case that they also offer a glimpse of our ancient selves. Their way of life stands in contrast with modern lifestyles, which changed for most humans only "yesterday" in evolutionary terms.

It is through this lens that Diamond sees the world, be it the Pygmies of the Congo, the !Kung in Botswana or highland New Guinea bands. He doesn't promote returning to a traditional lifestyle, but he argues that there is perspective to be gained in looking back. Such groups are a reminder, he says, of how humans survived for thousands of years.

As always, his details are remarkable. Diamond devotes a whole section just to crying babies. Rather than let a baby "cry it out," Pygmy and !Kung groups comfort a sobbing baby within seconds. Or breast-feeding: Modern mothers typically breast-feed infants (if at all) on mom's schedule, not the baby's — quite different from traditional societies today.

But it's not all sweetness. Diamond explores a bloody New Guinea tribal war that raged for years in the 1960s, fought with spears and arrows by everyday people who often knew their enemies by name. In contrast, modern war deploys metal tools and professional soldiers against faceless enemies. Different, but with similar consequences: death, resources lost, energy expended. Per capita, mortality in the New Guinea conflict rivaled or eclipsed that of 20th century European battles, leading Diamond to examine conflict resolution in each culture.



The book also analyzes treatment of the elderly, everyday dangers and religion. There is plenty to learn from traditional people, not least because we "modern" people are hardwired for their lifestyle, not ours. — *Nathan Seppa*

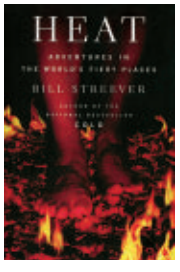
Viking, 2012, 499 p., $36

Heat: Adventures in the World's Fiery Places

Bill Streever

On the heels of his previous book *Cold*, biologist Bill Streever takes the next logical step and sets out to understand what happens, scientifically speaking, when things get hot.

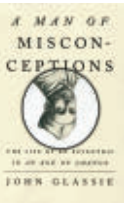
The result is part scientific narrative, part travelog. Streever visits nuclear blast sites and laboratories where supercollider experiments reach trillions of degrees Fahrenheit. He interviews physicists, geologists, firefighters and instructors who teach firewalking at corporate team-building seminars. He recounts the history of volcanoes that belch scorching pyroclastic flows, describes blistering fevers and explains what happens to the human body after a few days in the desert without water.



Heat is packed with anecdotes, and Streever's boundless enthusiasm for high-temperature topics makes the book an engaging read. He is at his best when relating his own adventures, such as an attempt — and, to his dismay, failure — to start fires with materials that would have been available to hominids in the ancient world. "If the world were populated only by people like me," he writes, "we would still be living in trees and eating raw fruit. Climate change would not be an issue."

But it is an issue. Streever doesn't linger on the subject, but he does keep track of the carbon emissions released into the atmosphere during his travels by plane and car, and the quantity is sobering. By burning fossil fuels, he points out, people now make daily contributions to a planet that is heating up. — *Allison Bohac*

Little, Brown and Co., 2013, 349 p., $26.99



A Man of Misconceptions

John Glassie

The eccentric life of the insatiably curious, but often wrong, 17th century scholar Athanasius Kircher is explored in this tale of his influence on science. *Riverhead Books, 2012, 335 p., $26.95*

Cycling Science

Max Glaskin

The physics of two-wheeled locomotion gets deep coverage in this illustrated overview for the bike-obsessed. *Univ. of Chicago, 2012, 192 p., $30*

Walking Sideways

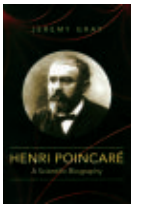
Judith S. Weis

A biologist pens a tribute to crabs, exploring everything from their life cycles and behavior to the many ways humans eat them. *Cornell Univ., 2012, 224 p., $29.95*

Guesstimation 2.0

Lawrence Weinstein

A handy guide helps readers learn to approximate almost anything, from the energy needed to ship a tomato to the length of toilet paper used in the United States. *Princeton Univ., 2012, 359 p., $19.95*



Henri Poincaré

Jeremy Gray

This comprehensive biography of the mathematician details his life and contributions to math, physics and philosophy. *Princeton Univ., 2012, 593 p., $35*

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Weighing factors in obesity

In "Obesity research gets weightier" (*SN: 12/29/12, p. 28*) Nathan Seppa says that green space and a nearby grocery store reduce the incidence of obesity. I think I understand how the green space affects it (clean air, physical activity, et cetera), but I don't understand how the grocery store does. Is there anything showing a connection?

Ted Grinthal, Berkeley Heights, N.J.

The connection lies in access to fresh fruits and vegetables, which fight obesity. The researchers counted grocery stores that sold fruits and veggies within a half mile of neighborhoods (a positive) and fast-food shops in that radius (a negative). These yielded a nutrition score, which was combined with a physical activity score. Obesity rates in kids were 59 percent lower in neighborhoods that scored well on both, even after accounting for race, income and other factors. "If we want to reduce the obesity epidemic," says Lawrence Frank of the University of British Columbia in Vancouver, "we need to reverse the way we're building our communities." — Nathan Seppa

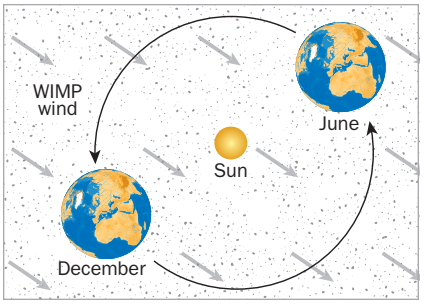
Science as an ongoing process

"Debunked science" (*SN: 12/29/12, p. 31*) was a welcome addition to your year-end issue. While your magazine has stressed that its reported findings are just a part of the scientific process of discovery, it is important and refreshing to see follow-up research that may reach alternate or contradictory conclusions.

Roger C. Tollefsen, Hampton Bays, N.Y.

Corrections

The article "Gulf Stream may melt methane" (*SN: 12/1/12, p. 12*) says that changes in the Gulf Stream have heated "sediments in a strip along the North Atlantic seafloor by 8 degrees Celsius." The 8 degree rise actually refers to the maximum observed rise in ocean temperature, which occurs at 500 meters water depth. Any sediments at those depths could experience similar heating from the overlying water.



A graphic in the article "Light in the dark" (*SN: 1/12/13, p. 18*) showed the Earth revolving around the sun in a clockwise direction as seen from above the North Pole, but should have depicted a counterclockwise direction. The corrected graphic is shown above.

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Sociologist Jennifer Carter (left, in jersey number 9) suited up for the Cincinnati Sizzle as part of her graduate research.

Tackling women's pro football

Jennifer Carter's research on women's professional football is so hard-hitting that it left her bruised and nursing a torn hamstring. Carter, a graduate student in sociology at the University of Cincinnati, started observing the inner workings of a team in the Women's Football Alliance from the sidelines during the 2011 season. Her goal: to figure out how women train for and protect themselves against the brutal physical contact of a sport associated, perhaps more than any other, with men.

With encouragement from the team's players, Carter (shown below) suited up as a defensive back for the Cincinnati Sizzle. At the annual meeting of the American Sociological Association last August, she presented her initial results.

She found that players in the WFA — which has over 50 teams and more than 1,800 players — revel in bone-jarring hits as much as any multimillion-dollar masher in the National Football League. But women in pro football earn as little as $1 per game and cover their own expenses for uniforms, equipment, field rentals and travel. What's more, football equipment isn't designed for female bodies; women buy or borrow men's helmets, shoulder pads and shoes. As concerns grow about concussions among male athletes wearing state-of-the-art gear, WFA players search for inexpensive, secondhand helmets.

"Players I knew sometimes got concussions and expressed concerns about head injuries, but no one changed their style of play as a result," Carter says.

While female players avidly lift weights to get stronger, they tend to know little about football-specific weight training. Off-season conditioning occurred without coach or trainer supervision. And while WFA players play through most injuries, heeding tackle football's tough-guy code, women have a harder time than men explaining their bruises, cuts and scrapes. It was easier for one Sizzle player to let her coworkers assume that she'd gotten badly bruised in an accidental fall, Carter says.

Carter plans to finish her research from the sidelines. She vividly remembers, though, the first hit she took in a game. While chasing a ball carrier on a kickoff, the excited rookie got flattened by an opponent she never saw. Out-of-the-blue, body-blasting pain like that is hard to describe, she says. But at least she can begin to describe how women transform themselves into football players. — *Bruce Bower*

Girls on the gridiron

Women have been playing on the football field for almost 100 years. What began as a novelty act for 1920s halftime shows and the occasional women's college team (above, a team from Gustavus Adolphus College in Saint Peter, Minn.) got a boost with the creation of a female U.S. semipro league in 1965. This Women's Professional Football League started as a gimmick with teams in Cleveland and Akron but soon grew, adding cities as interest rose. Since then, women's pro football has spread; leagues such as the WPFL have grown, merged and been transformed. Today, two main leagues — the Independent Women's Football League and the Women's Football Alliance — field dozens of teams, including the Palm Beach Punishers and the New York Knockout.
— *Sarah Zielinski*

CLOCKWISE FROM TOP: ROB SARGENT; POGUE/*MINNEAPOLIS JOURNAL*, COLLEGE AND LUTHERAN CHURCH ARCHIVES AT GUSTAVUS ADOLPHUS COLLEGE; UNIV. OF CINCINNATI

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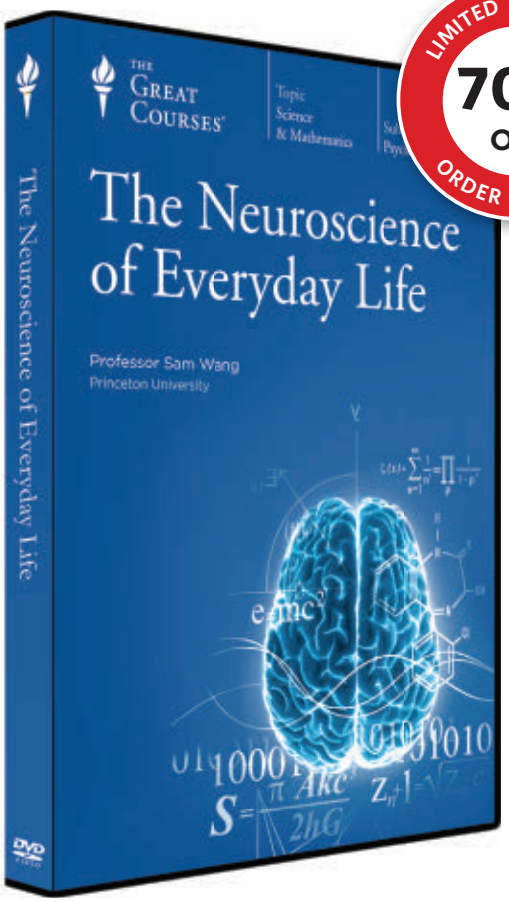

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I wasn't looking for trouble. I sat in a café, sipping my espresso and enjoying the quiet. Then it got noisy. Mr. Bigshot rolled up in a roaring high-performance Italian sports car, dropping attitude like his $14,000 watch made it okay for him to be rude. That's when I decided to roll up my sleeves and teach him a lesson.

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

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