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ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ JUNE 1, 2013

Cane's comeback

How high fructose corn syrup is losing the sweetener war

(and why it doesn't matter)

Maya Civilization's Ritual Birth

Cannibalism at Jamestown

Some Kids Primed for Math

The History of the Future?

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In The News

Features

Departments

COVER Cane sugar's reputation has improved due to bad press about high fructose corn syrup. But the case against corn-based sweeteners is thin. *James Worrell/The Image Bank/Getty Images*

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FROM THE EDITOR

The complexities of eating in today's world

Eating and sleeping are so basic to our survival, you would think they would be pretty instinctual. But by all accounts, we in the United States sleep too little and eat, if not too much, then at least unhealthily (think salt, trans fats and sugar). Considering the many thousands of years our species has existed, you might expect humans to do better.

But we live in a vastly different world from our hominid ancestors. The night, now lit by electric lights, televisions, computer screens and all kinds of gadgets, is not the same place where people slept long ago. And mealtime isn't the same, either. A new report on Page 13 shows that by 2 million years ago, early hominids were hunting gazelles and snatching antelope heads from the abandoned kills of other predators in order to eat the brains.

Today we have forsaken purloined brains for a plenitude of processed delights. Grocery shelves are chock-full, stocked with formulations of food like nothing ancient people ever ate: Mountain Dew, Twinkies, PowerBars. As Laura Beil's story on Page 22 reveals, a central ingredient in many of these products, high fructose corn syrup, began its life as a scientific achievement. Starting with cornstarch, scientists were able to alter the ratio of glucose and fructose, upping the fructose to make a sweeter sweetener. Corn syrup is also cheaper and easier than cane sugar for food companies to work with. So today, HFCS is what gives most sodas and a lot of other processed foods their sweet taste.

But then there was a backlash. As obesity rates climbed in tandem with HFCS consumption, some wondered if this "unnatural" sweetener could be making people fat. Thus began a movement against HFCS. That controversy has led to some careful science designed to look for any health effects specific to fructose, as Beil describes in her story. There are some, it turns out, but the overwhelming consensus is that it is the overall consumption of all things sweet — whether flavored with cane sugar, honey, HFCS or regular corn syrup — that most threatens health. In the body, excessive amounts of sugar turn into fat, whichever type you eat. And, in some people, too many sweets can cause serious problems with the insulin system, putting them at higher risk of type 2 diabetes. To keep eating and sleeping simple, the best policy may be moderation.

— Eva Emerson, Editor in Chief

SANDY SCHAEFFER

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Say What?

Love-dart *LUHV dart*\ *n.*

A small, hard spike that land-dwelling snails in at least nine families jab into a partner during mating. Each snail is a hermaphrodite with working male and female parts, but this spike does not deliver sperm. It injects mucus that contains substances that can increase the amount of sperm a partner stores. Some species launch a detachable dart and others stab repeatedly, more than twice per second for nearly an hour in *Euhadra subnimbosa*. In a less speedy stabber, *E. quaesita*, mucus more directly foils rival suitors. A jabbed snail is slow to mate again, researchers at Tohoku University in Japan report in the March *Animal Behaviour*. —*Susan Milius*

Science Past | FROM THE ISSUE OF JUNE 1, 1963

"DRAW" BODY BY SOUND — A new device now maps the body's internal organs with sound waves.... Shaped like an oversized fountain pen, the transducer is held over the body above the internal organ to be studied. Short pulses of ultrasonic energy radiate out, and harmlessly bounce back from the internal surfaces. The time they take to return is analyzed, and results are recorded immediately on the instrument's screen. A "map" of the organ inside the body can thus be studied. The principle is the same as that of sonar systems using sound waves to locate objects under water.... Formerly doctors have relied upon X-rays or other means to obtain information about the interior of the body. But radiation dosages make these procedures dangerous.

Science Future

June 24

Last day to see the Picturing Science exhibit on high-tech imaging at New York City's American Museum of Natural History. See bit.ly/SFpicsci

June 15

The Exploratorium in San Francisco invites visitors to make their own toys at Explorables: Science You Can Play With. See bit.ly/SFsciplay

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ENVIRONMENT

See good news for birds in "So far, the great tit has coped with climate change."

LIFE

Fossils show how birds shifted their weight as they evolved. Read "Birds may have had to crouch before they could fly."

Flowerlike corals pulsate to boost photosynthesis by algae harbored inside. See "Why corals do calisthenics."

RANDOMNESS

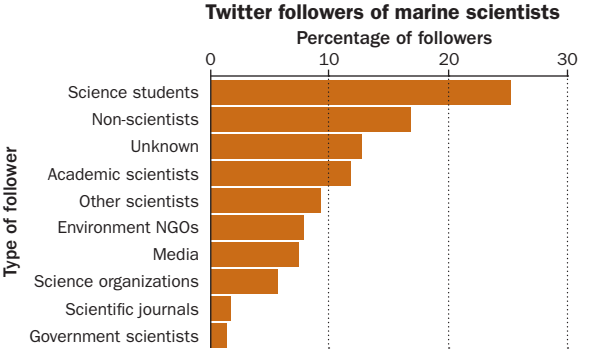
Tom Siegfried examines theories of generosity in "Greed may breed financial fitness, but evolution allows unselfishness to survive."

Mystery Solved | EYE ON THE BALL

A new study may settle a debate between scientists and professional baseball players. Hitters swear they can keep their eyes on a 90-mile-an-hour fastball, but scientists have said that's much too fast for the brain to track a ball's path. A March 13 study in *PLOS ONE* shows that the players are mostly right: They are capable of following the ball, but they subconsciously choose not to. Researchers found that two elite cricket players (cricket requires roughly the same reaction time as baseball) kept their heads perfectly aligned with the ball as it approached, showing they could track it. But their eyes jumped ahead, anticipating the ball's trajectory and nearly always ending up at the point of bat-ball contact. The next step is seeing whether all-star major-league hitters have that same skill. —*Andrew Grant*

Science Stats | TWEET YOUR SCIENCE

Twitter is giving scientists a new way to share their studies and publications with colleagues, the media and even politicians. A new analysis by marine scientists of their own Twitter network found that other scholars made up the biggest group of followers, but 45 percent were nonscientists, the media and the general public. SOURCE: E.S. DARLING *ET AL*/ARXIV.ORG 2013



CLOCKWISE FROM TOP LEFT: JANGLE1969/WIKIMEDIA COMMONS; NIOO-KNAW/DREAMSTIME; MATT BROWN/ISTOCKPHOTO

“Religion and public ritual might be the most important factors in the development of Maya civilization.”
— FRANCISCO ESTRADA-BELLI, PAGE 12

In the News

A facial reconstruction based on a skull (inset) found in Jamestown, Va., depicts a girl whose remains were eaten. The skull bears linear marks made in a failed attempt to open it.

MAIN: STUDIOEIS, DON HURLBERT/SMITHSONIAN; INSET: DON HURLBERT/SMITHSONIAN

STORY ONE

Cannibalism in colonial America

Girl’s remains shed light on Jamestown’s gruesome ‘starving time’

By Bruce Bower

WASHINGTON, D.C. — Hunger turned horrifying among Colonial-era residents of Virginia’s Jamestown settlement. An analysis of a partial skull from a teenage girl unearthed last summer indicates that her body was cannibalized after she died, scientists reported May 1 at the Smithsonian Institution’s National Museum of Natural History.

This unfortunate girl, dubbed Jane by the team that studied her remains, confirms several colonists’ written accounts of last-ditch cannibalism at Jamestown’s walled fort during the winter of 1609 to 1610. Historians refer to those months as Jamestown’s “starving time,” when sickness, starvation and a siege by neighboring Powhatan Indians nearly wiped out the settlement.

Jane represents the only skeletal evidence of cannibalism in the Americas during colonial times. “We don’t think Jane was alone in being cannibalized at Jamestown,” said historian James Horn of the Colonial Williamsburg Foundation.

Jane’s partial skull and right shin bone were excavated in a structure’s cellar by a team led by William Kelso, chief archaeologist of the Jamestown Rediscovery Archaeological Project. The cellar had become a refuse pit by 1610. Aside from Jane’s remains, researchers

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found military equipment, pots, seashells and the remains of horses, dogs and other animals.

After observing that Jane's skull had probably been chopped in two, Kelso called in a group led by Smithsonian anthropologist Douglas Owsley to analyze the girl's remains.

Closely spaced cuts in Jane's forehead could have been made only on a motionless body, so it's likely that the young girl died before the cuts were made, Owsley said. After that failed attempt to open Jane's skull, her body was positioned face down. A person wielding a small axe or cleaver then split her skull in half with four forceful chops.

Cuts and puncture marks on the left side of the cranium and the lower jaw resulted from someone using a knife in a sawing motion to remove the brain and tissue from the face and throat, including the tongue.

"The person who did this was very hesitant and had no experience at this type of activity," Owsley said.

Jane's shin bone was chopped off near the knee joint, in a cut similar to a traditional butchery technique, he added. The precision of that cut suggests that a more competent person may have dismembered the body's legs, Owsley said, while someone less experienced focused more haphazardly on the head.

Too little of Jane's skeleton was found to test for other clues to cannibalism, such as polished areas that form on bones that have been boiled in pots and limb bones broken open to obtain marrow.

The cause of Jane's death can't be determined from her remains, which represent about 10 percent of her complete skeleton.

Jane probably reached Jamestown in 1609 on one of six storm-damaged ships that had been part of a larger fleet carrying supplies and settlers from England, Horn said. Most of the desperately needed food had spoiled on board. Settlers' attempts to get food from the Powhatan led the tribe to attack and surround the Jamestown fort. As winter set in, the settlers became desperate. They ate horses, dogs, rats, snakes and even boiled boots, according to written accounts. As a last resort, human corpses were consumed.

> "We don't think Jane was alone in being cannibalized at Jamestown."
>
> JAMES HORN

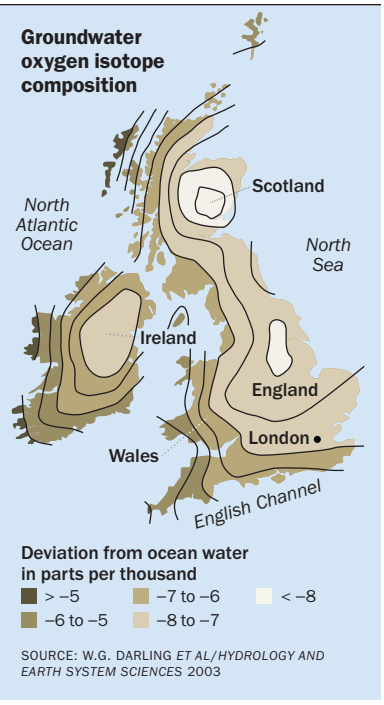
Only 60 of 300 settlers survived that brutal winter. More colonists had crossed the ocean to Jamestown by spring.

Jane now returns from that tumultuous time, thanks to a facial reconstruction led by Owsley. CT images helped researchers assemble a 3-D model of the girl's skull. A group of sculptors and artists then collaborated with the scientists to create a likeness of Jane. Tooth development and the growth stage of a partial knee joint put Jane's age at about 14 years.

The chemical composition of Jane's recovered bones reflects a European diet of mainly wheat and meat. Based on that evidence and the depth of the archaeological layer in which her partial remains were found, researchers suspect that Jane arrived in Jamestown in August 1609. If so, she reached the settlement just a few months before the worst stretch of "starving time."

Researchers plan to scrutinize DNA samples taken from Jane's bones, though Owsley said it's improbable that investigators will be able to identify living genetic relatives of the girl. ■

Settlers spent the "starving time" of 1609–10 in James Fort, in the Virginia colony, shown under construction in the illustration below.



SOURCE: W.G. DARLING *ET AL/HYDROLOGY AND EARTH SYSTEM SCIENCES* 2003

Back Story | JANE'S ORIGINS

In addition to providing information about a person's death and its aftermath, human remains can reveal where and how someone lived. Measuring the ratio of different forms of oxygen in Jane's teeth indicates that she probably spent her childhood in coastal southern England. Oxygen comes in different forms called isotopes, each with a different number of neutrons in the nucleus. The oxygen in surface water and groundwater contains varying ratios of the two most common isotopes, oxygen-16 and oxygen-18, depending on the water's temperature, distance from the ocean, altitude and other factors. Since the oxygen in a growing person's teeth comes almost entirely from drinking water, we all carry around in our mouths a record of the oxygen-18/oxygen-16 ratio in the place where we grew up. Jane's teeth suggest she grew up in an area of moderate oxygen-16 enrichment. Combined with historical information about the origins of early Jamestown settlers, that information allows researchers to say with a fair degree of certainty that she came from the southern coast of England.

FROM TOP: S. EGTS; SIDNEY KING/COLONIAL NATIONAL HISTORICAL PARK

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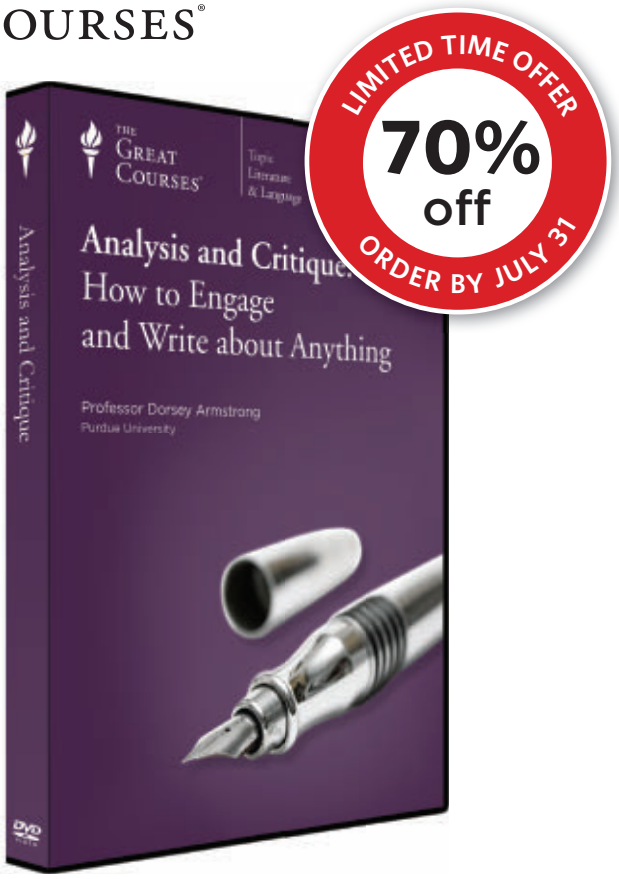

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Genes & Cells

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Mutation makes H5N1 flu lose grip

Lab-induced change makes virus unable to bind bird cells

By Tina Hesman Saey

A mutation that helped enable airborne transmission of the H5N1 flu virus between ferrets nearly obliterates the ability of the virus to latch onto avian cells. At the same time, the mutation slightly boosts the virus's ability to infect human cells, researchers report April 24 in *Nature*.

The finding follows up on controversial research published last year that transformed the H5N1 virus, a microbe usually restricted to birds, into one that could spread between ferrets through the air (*SN: 6/2/12, p. 20; 7/14/12, p. 8*). The mammals are commonly used as stand-ins for humans in flu research.

Some scientists and policy makers questioned whether such research should be done at all. Others argued that the work could help spot viruses poised to become pandemic strains and might point to vaccine targets.

The new study also shows that a mutation can have different effects in different flu strains, something that might not have been known without the earlier research.

In the course of becoming a human disease, avian flu viruses generally develop a preference for grasping sugar molecules called receptors on the surfaces of human cells. One common mutation that helps viruses do that, called Q226L, changes an amino acid in the hemagglutinin protein, the molecule that gives the virus the H in its name. Hemagglutinin acts as a grappling hook to snag cells, making it easier for the virus to infect them. The Q226L mutation, which occurs in the experimental H5N1 work and in influenza strains that caused pandemics in 1957 and 1968, twists the hemagglutinin protein to better hang onto human cells.

Virus strains with the mutation usually retain some power to hold onto bird cells, but not in the case of H5N1, says structural biologist and study coauthor Steven Gamblin of the MRC National Institute for Medical Research in London. The single amino acid alteration flips the H5 hemagglutinin from a protein with a high affinity for avian cells and almost none for human cells to one that clings weakly to human receptors but cannot get any handle on bird receptors. The mutant H5 binds human sugars 200 times more strongly than it does bird receptors, Gamblin and his colleagues found.

Still, the mutant H5 gets only the weakest of holds on human sugars, says Ram Sasisekharan, an MIT biochemist who has conducted similar studies on H5N1 and other influenza viruses. The strength of its grip does not rise above the threshold typically needed for other flu viruses to infect human cells, making the role of the mutation in transmissibility a mystery.

And because the mutant H5 can no longer bind to avian cells, viruses carrying the mutation probably would not be able to replicate in birds, Gamblin says. That could mean that the mutant virus may not be able to jump directly from birds into people.

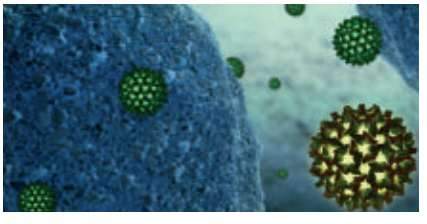
Hepatitis B has ancient roots

Bird genomes show virus is at least 82 million years old

By Tina Hesman Saey

A virus that causes liver diseases in people may have infected birds that shared the planet with dinosaurs.

More than 82 million years ago, a hepatitis B virus infected an ancient bird and got stuck in its genome, researchers report April 30 in *Nature Communications*. Using fragments of DNA found in modern-day zebra finches, evolutionary biologist Alexander Suh and colleagues at the University of Münster in Germany pieced together a complete genome of the ancient virus. Their analysis suggests that hepatitis B is about 63 million years older than previously thought.



Hepatitis B (illustrated here with human cells) infected birds 82 million years ago, according to a new study of virus fragments embedded in the DNA of modern-day zebra finches.

Hepatitis B doesn't normally insert itself into the genome of an infected person or animal. But in 2010, Cedric Feschotte of the University of Utah found traces of hepatitis B lurking in the zebra finch genome. Using viral DNA fragments, Feschotte put the virus's age at a minimum of 19 million years old.

For the new study, Suh and colleagues searched for remnants of the virus in the DNA of various living bird species. By looking at how long ago those birds' common ancestors lived, Suh's team calculated the age of the virus. It turned out that the common ancestor of all birds carrying remnants of the virus lived about 82 million years ago.

Given the breadth of data that Suh's team worked with, the extreme age of the virus didn't surprise Feschotte. "But," he adds, "I think it's pretty cool."

SOMERSAULT18:24

Health & Illness

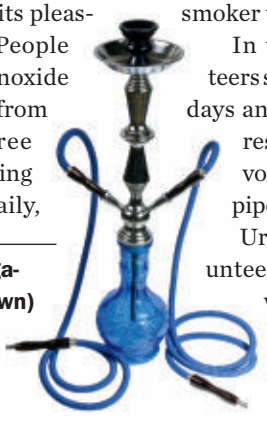
For longer versions of these and other Health & Illness stories, visit **www.sciencenews.org**

Hookah smoking far from safe

Water pipes deliver big doses of toxins

By Nathan Seppa

The tobacco-and-fruit mixture smoked in public hookah bars might be considerably more dangerous than its pleasant scent would suggest. People absorbed more carbon monoxide and benzene, a carcinogen, from smoking water pipes three times a day than from smoking half a pack of cigarettes daily, researchers report in the May *Cancer Epidemiology, Biomarkers & Prevention*.



Compared with smoking cigarettes, using a hookah (shown) sends more carbon monoxide and benzene into a smoker's body.

Researchers used pastes chosen by the participants that were 5 to 10 percent tobacco combined with honey, molasses and bits of fruit. The paste goes in the bowl of the pipe, which is covered with perforated foil and topped with a burning piece of charcoal, says coauthor Peyton Jacob III, a chemist at the University of California, San Francisco. The smoker then inhales.

In the study, 13 healthy volunteers smoked only a hookah for four days and then, after a week with no restrictions, only cigarettes. The volunteers averaged three water pipe sessions or 11 cigarettes daily. Urine tests showed that the volunteers had higher benzene levels when smoking hookahs. Benzene inhalation is associated with leukemia and lung cancer. The volunteers' tests also showed higher levels of pyrene, a polycyclic aromatic hydrocarbon, or PAH, when smoking the hookah. Similar amounts of the probable human carcinogen acrylamide and the PAH phenanthrene showed up during cigarette or hookah smoking. Exposure to PAHs is linked to cancer and immune problems (*SN: 3/23/13, p. 19*).

Breath tests showed that levels of carbon monoxide were 2.5 times greater in volunteers after the water pipe sessions than after cigarette smoking. The volunteers' blood samples while smoking the water pipe showed about half as much nicotine as when smoking cigarettes, but the level was enough to be addictive.

"This is a great addition to the literature," says Thomas Eissenberg, a psychologist at Virginia Commonwealth University whose research has found toxic substances in hookah smoke. The new paper extends his findings by detecting carcinogens and other bad actors in water pipe smokers themselves, he says.

Circumcision alters penis flora

Different mix of microbes may reduce HIV susceptibility

By Nathan Seppa

Uncircumcised men harbor more bacteria around the head of the penis than do circumcised men, and the mix of microbial species is decidedly different in the two groups, researchers find.

Whether these changes explain why circumcised men are less likely to get infected with HIV remains unclear. But the findings identify previously unknown differences between a warm, moist environment under the foreskin and the comparatively dry surfaces found on circumcised men.

"It's a very promising line of research," says Robert Bailey, a biologist and epidemiologist at the University of Illinois at Chicago, who wasn't part of the study team. "But it's far from really providing the story on the mechanism for the increased risk of HIV infection through the foreskin."

The report, which appears in the March/April *mBio*, finds that when the foreskin is removed from the head of the penis, resident microbes become exposed to oxygen and many flee the scene.

50–60 percent

Reduction in HIV acquisition risk from male circumcision

To measure these changes, the researchers enlisted 156 uncircumcised, married men in Uganda and obtained swabs from under each man's foreskin. Roughly half of the men were then randomly assigned to get circumcised. A year later, researchers again took swabs.

The later samples revealed substantially less bacteria in the circumcised group and changes in the diversity of bacteria that remained. Levels of 12 kinds of anaerobic bacteria, which need an environment devoid of oxygen, had decreased.

Circumcision provides heterosexual men with considerable, but not total, protection against infection by HIV and other sexually transmitted viruses. Does changing the penis microbiota account for this protection? "We can't say that our study answers that question, but we're definitely chipping away at it," says microbiologist Lance Price of George Washington University in Washington, D.C.

Price and his coauthors suggest that high amounts of bacteria and the presence of anaerobic microbes in uncircumcised men might contribute to inflammation, which would facilitate infection by HIV lodged in the foreskin.

Another alternative is that having additional bacteria present might contribute to ulcerations, which also promote viral entry, suggests Bailey.

APTYP_KOK/SHUTTERSTOCK

Mind & Brain

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Infants perceive world around them

Neural responses linked to visual awareness by 5 months

By Bruce Bower

Babies' brains signal a budding awareness of the visual world by 5 months of age, a new study concludes. But some researchers are skeptical that these neural surges indicate conscious experience.

From age 5 months to 15 months, the brain begins developing the ability to register and remember sights, cognitive neuroscientist Sid Kouider of École Normale Supérieure in Paris and his colleagues report. The researchers showed babies images that included faces flashed on a screen. The pace started at a speed so fast that even adults wouldn't consciously notice the images, then gradually slowed. While viewing the images, infants displayed a sequence of rapid brain responses that first signaled unconscious and then conscious perception of faces, Kouider's team reports in the April 19 *Science*.

"We weren't expecting to see any evidence of a neural marker for consciousness in 5-month-olds," Kouider says. Yet babies at that age exhibited a weak, delayed version of a brain response that occurs when adults report seeing a face flashed just long enough to be consciously perceived.

Stronger and faster brain responses corresponding to visual awareness emerged in 12- and 15-month-olds, Kouider found, although older infants still fell well short of the adult pattern.

Infants, including this 5-month-old boy fitted with an electrode-covered cap and held by his mother, display electrical brain responses possibly representing visual awareness.

Cognitive neuroscientist Charles Nelson of Harvard Medical School says he sees no clear connection between the findings in infants and the electrical responses in adults' brains. "I would be reluctant to attribute the same mental operation, such as consciousness, to infants and adults simply because of similar patterns of brain activity," Nelson says.

In the study, 5-month-olds, 12-month-olds and 15-month-olds sat on their mothers' laps while wearing an electrode-studded cap that measured electrical activity on the brain's surface. The babies saw three scrambled images and a woman's face, flashed on a computer screen for various amounts of time, accompanied by bell sounds for each image that created a simple melody to attract the infants' attention.

Adults don't report seeing a face and don't display neural signs of consciousness until each image appears for nearly one-third of a second. For 12- and 15-month-olds, each image had to be presented for about three-quarters of a second — and for almost one second for 5-month-olds — for the children to indicate conscious perception by looking toward the faces and generating the proposed brain signature of visual awareness.

Bats map in 3-D on the fly

Flying mammals build 3-D mental maps that appear to work differently from the 2-D maps that rats and other ground-dwelling animals construct, researchers report in the April 19 *Science*. Researchers implanted electrodes in the brains of Egyptian fruit bats (*Rousettus aegyptiacus*, shown) and strapped lightweight wireless recording devices to the animals' heads that measured neural activity as the animals flew around a room. Individual neurons known as place cells perked up when bats zoomed through particular spaces, report Michael Yartsev and Nachum Ulanovsky of the Weizmann Institute of Science in Rehovot, Israel. Just as spots on a map represent locations, each place cell corresponded to a specific area of the room. Like cartographers charting new lands, bats sketch mental maps of spaces they fly through. But unlike cartographers, bats use their place cells to represent three dimensions. —*Meghan Rosen*

FROM TOP: S. KOUIDER; COURTESY OF ORGANIZATION FOR BAT CONSERVATION AND STEVE GETTLE PHOTOGRAPHY

Brain region tied to math progress

Advancement with tutoring linked to hippocampus size

By Meghan Rosen

A child who is good at learning math may literally have a head for numbers. The size and connectivity of some brain structures are associated with how much kids' math skills improve after tutoring, researchers report April 29 in the *Proceedings of the National Academy of Sciences*.

Certain measures of brain anatomy were more closely tied to learning potential than traditional gauges of ability such as IQ and standardized test results, says study coauthor Kaustubh Supekar of Stanford University. These factors include the size of the hippocampus — a string bean–shaped structure involved in making memories — and how connected the area was with other parts of the brain.

The findings suggest that kids struggling with their math homework aren't necessarily slacking off, says cognitive scientist David Geary of the University of Missouri in Columbia. "They just may not have as much brain region devoted to memory formation as other kids."

The study could give scientists clues about where to look for sources of learning disabilities, he says.

Scientists have spent years studying brain regions related to math performance in adults, but how kids learn is still a mystery, Supekar says. He and colleagues tested IQ and math and reading performance in 24 8- and 9-year-olds, then used MRI scans to measure the sizes of different brain structures and the connections among them.

"It's like creating a circuit diagram," says study leader Vinod Menon, also of Stanford.

Next, the kids began a tutoring program that focused on speedy problem-solving and math skills such as counting strategies and basic arithmetic. After eight weeks and about 15 to 20 hours of tutoring, the researchers tested the students' math abilities again and compared the kids' progress with the brain scans.

Overall, tutoring improved the kids' math skills, and the children with the biggest improvements had big hippocampi that were well connected to brain regions that make memories and retrieve facts.

"It's a very interesting and surprising finding," says cognitive neuroscientist Robert Siegler of Carnegie Mellon University in Pittsburgh. In adults, the hippocampus isn't all that involved in math, he says. But in kids, "it apparently is involved in math learning."

Humans

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After excavating through layers of construction at an ancient Maya site in Guatemala, researchers found a ritual plaza from around 3,000 years ago.

Maya civilization rooted in ritual

Cultural interactions spread across a wide territory

By Bruce Bower

Ancient Maya civilization was born of public rituals devised several thousand years ago as a result of mingling among groups spread across what's now southern Mexico and Guatemala.

That's the provocative conclusion of a report, published April 26 in *Science*, describing the excavation of that region's oldest known ceremonial structures. The excavations were at Ceibal, an early Maya settlement in Guatemala. These 3,000-year-old finds consist of remnants of a square platform and a long platform separated by a plaza, say archaeologist Takeshi Inomata of the University of Arizona and his colleagues. Significantly, the two structures run from east to west.

Renovations to the square platform transformed it into a 6- to 8-meter-high pyramid by around 2,700 years ago. A new version of the long platform was built behind the original at that time.

That layout, joining a square or pyramid with a platform in an east-west alignment, formed the centerpiece of ritual areas in many later Maya cities. Ceremonial structures at Ceibal and nearby sites got the cultural ball rolling, the researchers suggest, in a Maya society that eventually featured writing, a complex calendar and massive temples.

Radiocarbon dating at Ceibal challenges previous proposals that Maya civilization arose either on its own or from the direct influence of southern Mexico's Olmec civilization, which dates from roughly 3,500 to 2,400 years ago. Some archaeologists contend that an Olmec settlement near Mexico's Gulf Coast called La Venta crucially shaped ancient Maya practices.

But Ceibal's ceremonial structures were built about 200 years before comparable ones at La Venta, Inomata's team concludes. Similarly configured ritual buildings appeared at sites within 400 kilometers of Ceibal shortly after 3,000 years ago, the investigators say.

"Cultural interaction over a broad area was a key to development of Maya civilization," Inomata says.

Ceibal and nearby sites have yielded jade, obsidian and other valuable stones that were used to make axes as offerings to gods and then buried in ceremonial plazas. Traders of these precious stones from various groups witnessed and even participated in others' rituals, Inomata suspects.

Inomata's findings at Ceibal challenge the popular view that public rituals and public spaces appeared only after early civilizations established economic systems and social classes. "Religion and public ritual might be the most important factors in the development of Maya civilization," says archaeologist Francisco Estrada-Belli of Tulane University in New Orleans.

Olmec investigators praise the new Ceibal report but say it can't explain Maya civilization's roots. Ceibal's ceremonial structures may have preceded those at La Venta, but residents of an older Olmec settlement called San Lorenzo — which had a complex culture that archaeologists only poorly understand — might have erected such structures, remarks archaeologist John Clark of Brigham Young University in Provo, Utah. San Lorenzo's heyday ended around 3,150 years ago.

Art and religion flourished at San Lorenzo while Maya to the east were just learning to make pottery, says Yale University archaeologist Michael Coe. Olmec people may not have invented Ceibal's ritual setup, but they still forged a "mother culture" for the Maya and other ancient societies in that region, Coe says.

Inomata's team doesn't yet know the length of Ceibal's long platforms, so it's unclear whether ritual structures there were arrayed like those at later Maya sites, says archaeologist Rebecca González Lauck of Centro INAH Tabasco, Mexico, who directs La Venta excavations. La Venta's pyramid and platform stand near two massive stone sculptures unlike anything at Maya sites, she adds, indicating that Olmec ritual practices were different than those at Ceibal and other Maya sites. Only further excavations can illuminate cultural links between Olmec and Maya sites, González Lauck holds.

One thing is certain, she says: "There was contact between the Gulf Coast Olmec and the Maya lowlands, including Ceibal." ■

T. INOMATA

"Cultural interaction over a broad area was a key to development of Maya civilization." —TAKESHI INOMATA

Meat on human ancestors' menu

Kenya fossils offer earliest evidence of regular hunting

By Bruce Bower

Human ancestors living in East Africa 2 million years ago had a serious hankering for gazelle meat and antelope brains, fossils from Kenya indicate.

Butchered animal bones at Kenya's Kanjera South site provide the earliest evidence of both long-term hunting and targeted scavenging by a member of the human evolutionary family, anthropologist Joseph Ferraro of Baylor University in Waco, Texas, and colleagues conclude.

An early member of the *Homo* genus hunted small animals and scavenged predators' leftovers of larger creatures, researchers report April 25 in *PLOS ONE*. Along with hunting relatively small game such as gazelles, these hominids scavenged the heads of antelope and wildebeest-sized animals, apparently to add a side of fatty, nutrient-rich brain tissue to their diets.

Sites dating to as early as 3.4 million years ago had previously produced small numbers of animal bones bearing butchery marks made by stone tools, a possible indicator of occasional meat eating (*SN: 9/11/10, p. 8*).

"Hunting small animals may have been a regular behavior." MANUEL DOMÍNGUEZ-RODRIGO

Kanjera South has yielded several thousand complete and partial bones from at least 81 individual animals. Hominids hunted gazelles and other relatively small animals and hauled their take back to Kanjera South, the researchers say, as evidenced by the presence of complete skeletons from some animals. Stone tool marks indicate that hunters cut prey into parts before stripping flesh from the bones. The site contains no signs of cooking.

Few tooth marks of lions or other predators appear on these fossils, another clue that hominids must have killed the small game.

"Hunting small animals may have been a regular behavior of 2-million-year-old human ancestors," says anthropologist Manuel Domínguez-Rodrigo of Complutense University of Madrid.

Researchers also found disproportionately large numbers of skulls and lower jaws in the excavated remains of antelope and other animals larger than gazelles. That pattern best fits a scenario in which hominids retrieved heads left untouched by big cats. Several brain cases and jaws display dents and fractures created by hammering with stones to reach tissue inside, Ferraro says.

Carried babies reflexively relax

Physiological response in mice, humans may be adaptive

By Meghan Rosen

For human infants and mouse pups, bumping along in mother's arms (or mouths) acts as the ultimate pacifier: Crying stops, fidgety bodies go still and racing hearts thump more slowly, researchers report April 18 in *Current Biology*.

Carrying lulls mammalian babies into a trance that may improve their chances of survival, the study's authors suggest. Lugging around wriggling banshees is tough work; mouse mothers on the move fare better with babies that relax when carried.

"The idea makes sense," says pediatrician John Harrington of Eastern Virginia Medical School in Norfolk, who was not involved with the research. "If you're running away from a predator, you'd want your child huddled against your chest and quiet."

Scientists have previously tried to figure out what calms crying infants by studying parent diaries, but no one has examined the physiological effects of carrying babies, says Kumi Kuroda of Japan's Riken Brain Science Institute.

Her team stuck heart rate monitors onto 12 healthy babies and took videos of the infants as their mothers sat holding them, carried them around a room or laid them in a crib. The babies immediately relaxed when their mothers picked them up and walked briskly.

Young mice also calmed down when their mothers carried them, Kuroda's group found. Clamped in their mothers' mouths, pups tucked their legs to their bellies and stayed still; also, their heart rates slowed.

When researchers drugged the pups or numbed their necks so they couldn't sense that they were being carried, the animals struggled in their mothers' grasps. Moms carrying squirming babies took longer to get back to the nest than moms holding calm pups did.

In the wild, a mother who has to make a quick getaway may have to leave hard-to-hold babies behind, Kuroda says. Mammalian infants may have adapted to relax when carried.

"It's neat to draw parallels between different species, but we have to be careful when generalizing animal studies to humans," cautions child development researcher Rebecca Pillai Riddell of York University in Toronto. Even behaviors that look the same may have different purposes, she says.

But Kuroda says that in both humans and mice, infants' responses to being carried seem to be a way to collaborate with their mothers. "Carrying is necessary for the infant, so the infant cooperates by helping the mother."

Earth

"The Earth would have been a halogen-poisoned planet." —ZACHARY SHARP

Maybe Earth's chlorine blew away

Giant impacts could explain low levels seen today

By Erin Wayman

Earthlings may owe a debt of gratitude to the beating their planet took in its youth. Colliding miniplanets might have knocked away much of the chlorine on early Earth's surface, geochemists propose. Had that loss not occurred, the world's oceans would have been too salty for complex life.

The scenario could explain why Mars, which suffered fewer large impacts, appears to have more than twice as much chlorine as Earth does, the researchers report April 16 in *Earth and Planetary Science Letters*.

"The story seems to hang together pretty well," says James Brenan, a geologist at the University of Toronto. "Life, probably over a fairly long time, might have been able to adapt to this environment, though certainly things would be different than today."

The composition of ancient meteorites, which are remnants of the raw materials that built the planets, indicates that Earth should have 10 times as much chlorine as it does. The missing chlorine has perplexed scientists for decades. In 1995, geochemist William McDonough suggested that chlorine was dragged to Earth's center by the metals that form the planet's core.

"I wasn't happy with putting it in the core," says McDonough, of the University of Maryland in College Park. But he didn't know what else to do with it. Chlorine and other elements known as halogens don't readily dissolve in metals or often combine with other elements to form minerals found in rocks. Perhaps, he reasoned, under the intense heat and pressure of the core, chlorine might have become more willing to mix.

In fact, the core is probably not where the chlorine went. In lab tests, Zachary Sharp of the University of New Mexico in Albuquerque and David Draper of the NASA Johnson Space Center in Houston approximated the conditions of the core by combining iron, rocks typical of the mantle and a chlorine compound in a capsule heated to 1,900° Celsius under pressures about 150,000 times higher than Earth's atmospheric pressure at sea level. The result: Chlorine still didn't dissolve in iron. So chlorine probably isn't hiding out in the core, Sharp says.

After ruling out the possibility that Earth never accumulated chlorine in the first place, the pair concluded that when the incipient Earth rammed into giant planetary bodies more than 4 billion years ago, the repeated impacts blew the element away.

That scenario hinges on the peculiarity of chlorine. Unlike elements that mostly end up in rocks and metals, much of Earth's chlorine is in salt deposits and brines or dissolved in the ocean. Because the element is concentrated on the planet's surface, giant impacts could have stripped away a good chunk of Earth's chlorine supply, Sharp and Draper say.

Had the early impacts not happened, Sharp says, "the Earth would have been a halogen-poisoned planet." The oceans would be as salty as the Dead Sea, and the high salinity would reduce precipitation. With less rain, there would be less erosion on land and fewer nutrients washing into the sea.

McDonough acknowledges that the new work disproves his idea that chlorine is trapped in the core. But he's not yet convinced that cosmic crashes removed the element. Even with the massive collision that created the moon, the pull of gravity returned to Earth most of the material that had been kicked into space. "But I don't have a better idea," he says.

F.M. NICK

Greenland ice loss may level off

The increasing pace of Greenland's glaciers calving into the ocean may not be as bad as once thought, researchers report in the May 9 *Nature*. Though scientists have worried that a recent acceleration in calving could dramatically raise sea level if it continues, a computer simulation of four Greenland glaciers suggests that the rate of ice loss will stabilize. Faezeh Nick of the Université Libre de Bruxelles in Belgium and colleagues estimate that if global temperatures warm 2.8 degrees Celsius by 2100, the four glaciers could raise sea level by about 1 centimeter by that year. Applying the findings to the rest of the island's glaciers (including Rink Glacier, shown), the researchers predict Greenland could add as much as 18.3 centimeters to sea level by century's end. That amount is about 35 centimeters less than a previous estimate that extrapolated Greenland's current ice loss acceleration into the future. —*Erin Wayman*

Matter & Energy

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Cracked glass tells tales

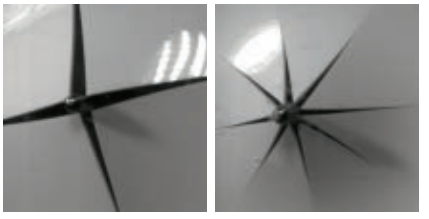
Velocity related to number of spokes in star-shaped fractures

By Andrew Grant

A shattered windshield has a story to tell.

The number of cracks that emerge in a plate of glass or Plexiglas relates to the speed of the object that broke it, researchers demonstrate April 26 in *Physical Review Letters*.

Most research into cracks has focused on parameters that determine whether a material remains intact when struck. Nicolas Vandenberghe and his colleagues at Aix-Marseille University in France decided to push glass and other materials past their breaking points to see if crack patterns could be connected to the properties of the impact that created them, something no one had done before, Vandenberghe says.



Pellets burrow through millimeter-thick Plexiglas plates. An 80-kilometer-per-hour pellet creates four cracks (left), while a 204-kph one creates eight.

His team set up small squares of glass and Plexiglas between 0.15 and 3 millimeters thick. The researchers shot at the squares with an air gun that fired 4-millimeter-wide steel pellets, about the size of BBs, at up to 432 kilometers per hour.

Using a high-speed camera to capture the instant of collision, the researchers broke more than 100 plates and then counted the cracks that extended outward in a star-shaped pattern from the point of impact.

After taking into account the type of material and its thickness, the number of cracks roughly doubled for every four-fold increase in the speed. For example, a 70-kph pellet caused an average of four cracks in 1-millimeter-thick Plexiglas plates, while a 280-kph one made eight.

The study's approach is clever, says Alan Zehnder, a mechanical engineer at Cornell University. But he points out that most impacts do not lead to orderly star-shaped crack patterns. He also notes that the experimental setup was on a much smaller scale than most everyday examples: The plates were much thinner than a typical windowpane, and the steel pellets were smaller than windshield-shattering rocks.

N. VANDENBERGHE/AIX-MARSEILLE UNIV.

Science & Society

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Google predicts market moves

Dow drops when searches for certain words increase

By Rachel Ehrenberg

The jittery, sweaty-palmed fear of losing money in the stock market leaves a signature in Google search data. Upticks in web searches for finance-related words such as *debt*, *stocks* and *portfolio* are good indicators of an impending downturn in the market, a new study shows. People enter such search terms less frequently before market gains, researchers report April 25 in *Scientific Reports*.

The new analysis is in line with previous work demonstrating that the frequency of some Google searches, such as those related to the flu, can gauge what a large number of people are worrying about.

"Think about it: When you feel good, you don't search for words like *flu* or *pharmacy*," says economist Paul Gao of the University of Notre Dame in Indiana.

Gao's work has shown that, by looking at a set of finance-related Google searches that appear to be motivated by fear, it's possible to predict whether the market will bounce back after a down day.

For the new study, scientists looked at roughly seven years of Google Trends data showing how often a particular term is queried relative to the total number of searches. The researchers collected data for 98 search terms, including finance-related words such as *gold*, *markets* and *unemployment* and less topical words like *kitchen*, *color* and *garden*.

Then the researchers compared the search data with the closing price of the Dow Jones Industrial Average on the first trading day of every week from January 2004 to February 2011. A downturn or uptick in the stock market was foreshadowed in the preceding days by the frequency of many of the finance terms.

"That was really intriguing to us," says Suzy Moat of University College London.

Moat and colleagues Tobias Preis of the University of Warwick in England and H. Eugene Stanley of Boston University also simulated buying or selling stocks. They found that buying or selling with the help of Google Trends data could bring in major profits, often far more than what would be earned by buying undervalued stocks and holding them.

That doesn't mean you should play the market based on search terms alone; not all words fit the pattern. And if a lot of people were to find out that search terms can be linked to market movements (say, by reading *Science News*), that signal could become useless or even be manipulated, Preis says.

Searching for profits Buying or selling stock based on the frequency of Google searches for finance-related words such as *debt* (shown) would have produced greater returns (blue line) than buying undervalued stock and holding it (red line). SOURCE: T. PREIS *ET AL*/*SCIENTIFIC REPORTS* 2013

Small groups foster interracial ties

Larger settings increase segregation, simulation finds

By Rachel Ehrenberg

Being able to choose friends from larger populations discourages friendships across races, finds a study examining the mathematical underpinnings of self-seeking behavior and group size. The results suggest that activities giving students from different backgrounds the opportunity to work together in the classroom can promote interracial friendships.

People often do self-segregate, says Stanford's Matthew Jackson, an expert in social economics and networks. Such segregation has consequences — such as influencing whether a student applies to college — and the new study shows how group size plays a role in that segregation, Jackson says.

The study describes mathematically how the size of a group influences who hangs out with whom. Sociologist Yu Xie and his University of Michigan colleague Siwei Cheng created a computer simulation in which a certain number of agents (representing students) made friendships. The simulated population was 80 percent one race and 20 percent another, and the researchers assumed that members would prefer friends belonging to the same race as themselves.

As the researchers ran the simulation, they varied the size of the populations from 50 to 1,000 people. As group size grew, the number of interracial friendships decreased, Xie and Cheng report in the April 30 *Proceedings of the National Academy of Sciences*.

Two hallmarks of modern life — the Internet and increasing urbanization — make it easier than ever for people to find and stick with people who are much like themselves, Xie says. The study results emphasize the need for continued vigilance in promoting integration, he says.

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Life

"I think there will always be debate about culture in animals." —LUKE RENDELL

Whales and monkeys learn socially

Mammals' shared feeding behaviors could be signs of culture

By Meghan Rosen

The phrase "monkey see, monkey do" also applies to humpback whales. Vervet monkeys and humpback whales both copy behaviors from their neighbors, researchers report in two studies in the April 26 *Science*. The studies suggest that, like humans, some wild animals pick up new habits from each other.

Accurately imitating one another's actions is a "potential building block of culture," says cultural evolutionist Peter Richerson of the University of California, Davis, who was not involved with the work. Complex culture builds upon people learning skills from each other, he says.

Scientists have previously spotted signs of social learning in monkeys, birds and other animals, but most studies relied on field observations or experiments with captive animals, says cognitive biologist Andrew Whiten of the University of St. Andrews in Scotland. The new monkey study applies experimental methods to wild animals.

Whiten's team trained four groups of vervet monkeys living in a South African game preserve to strongly prefer either blue or pink corn over the other color. Whiten and colleagues did this by soaking one color of corn in an aloe solution that the monkeys found disgusting.

Then the researchers waited four to six months, until the monkeys had given birth to a new generation, to bring out both colors of corn again. But this time, none was tainted with the nasty flavor. Most of the adult monkeys stuck with the color they had learned was tasty, and upon first encountering the corn, all but one of the 27 infants munched on the color that their group preferred.

Since adult male vervet monkeys migrate among groups, the researchers could observe that nine out of 10 males that moved from pink to blue groups or vice versa swapped their color preference and ate what the locals were eating.

The migrants may have been tapping into local knowledge about food, Whiten says. Or the animals could have been trying to fit in with their new friends. "Trying to be like others is a way of bonding with another group," he says.

Humpback whales learn from their peers as well, reports marine biologist Luke Rendell, also from the University of St. Andrews. In this case, the animals learn a feeding behavior.

Humpbacks commonly blow bubbles underwater to round up prey, but in 1980, a single whale was seen adding a new twist to the old technique: Before casting a bubble net, the whale whacked its tail on the sea's surface. The loud smack shakes up the water and may help the whale catch more prey. Since then, more and more whales have adopted the skill, called lobtail feeding.

The new study's results suggest that the more time whales spend with members of their species who lobtail feed, the faster they learn the technique.

Rendell's team drew on a 27-year record of whale sightings in the Gulf of Maine. Whale watchers made more than 73,000 sightings, logging date, identity and behavior information (including hunting technique) about each humpback they spotted. The research team then used network analysis to draw connections between whales — a social network for humpbacks.

The more lobtail-hunting connections a whale had, Rendell says, the more likely the animal was to pick up the skill. The results suggest that humpback whales, which researchers have previously shown learn songs from one another, also pass on hunting behaviors.

"In this population, you've got multiple traditions going on," Rendell says. He argues that this could constitute culture in the whales.

"Claims of tradition and culture in wild animals can be very contentious," says evolutionary anthropologist Rachel Kendal of Durham University in England. Rendell's group did a good job heading off potential criticisms, she says.

Still, Rendell says, "I'd love to be able to say that the case is closed, but I think there will always be debate about culture in animals." At least now when people have that debate, he says, humpback whales will have to be part of it. ■

Humpback whales (left) learn from their peers to slap the ocean's surface to help corral prey. In an experiment, youngsters and newcomers among troops of vervet monkeys (right) adopted the group's preference for either pink or blue corn.

LEFT: COURTESY OF JENNIFER ALLEN/OCEAN ALLIANCE; RIGHT: COURTESY OF ERICA VAN DE WAAL

Technology

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Winged robots take to the air

Researchers make flapping machines that mimic insects

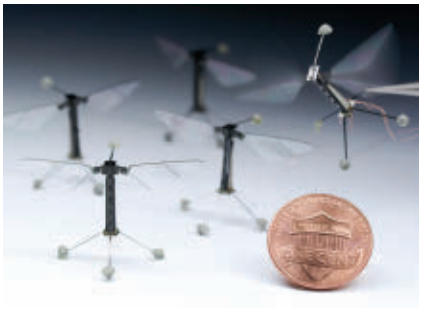
By Puneet Kollipara

Robots that can flap their wings, hover and dart around like a fly could help scientists better understand the finer points of insect aviation, researchers report in the May 3 *Science*.

Flies can easily evade a flyswatter's path or land on a surface blowing in the wind. Some research suggests that subtle changes in wing motion can produce impressively sharp turns. Emulating fly aviation in the lab with robots may illuminate details of insect flight. But doing that has proved difficult.

"People have been trying to build flapping devices like this for years," says Michael Dickinson, a bioengineer at the University of Washington in Seattle who wasn't involved in the work.

Robert Wood of Harvard University and colleagues had to improvise components to develop bodies, wings and muscles for their flying minibots. For the muscles, they used ceramic materials that display piezoelectric properties — meaning the materials can contract in response to an electric field. The researchers attached two flight muscles to a carbon-fiber skeleton and linked each muscle with a wing via plastic hinges at the skeleton's top.



Minirobots (shown with penny for scale) inspired by the aerobatic prowess of flies could improve understanding of the complexities of insect aviation.

An oscillating electric field contracts the piezoelectric muscles, causing the wings to flap. Changing the field's strength or frequency produces a different flapping intensity or rate. The researchers programmed a computer to interpret information from real-time videos of the robot and tell the wings when to flap and rotate.

It took Wood's team a decade to get a robot to fly (*SN: 12/15/12, p. 22*). One night last summer at 3 a.m., Wood says, one of his students e-mailed him "a really cool video" of a robot taking off, hovering and briefly flying. Since then the researchers have created numerous prototypes, making improvements and conducting tests.

The best robots' wings can flap 120 times a second, almost as often as real flies' wings do. The robots use roughly as much power — about 19 milliwatts — as insects similar in size. The machines can hover, move back and forth between points and stay airborne for more than 20 seconds before crashing.

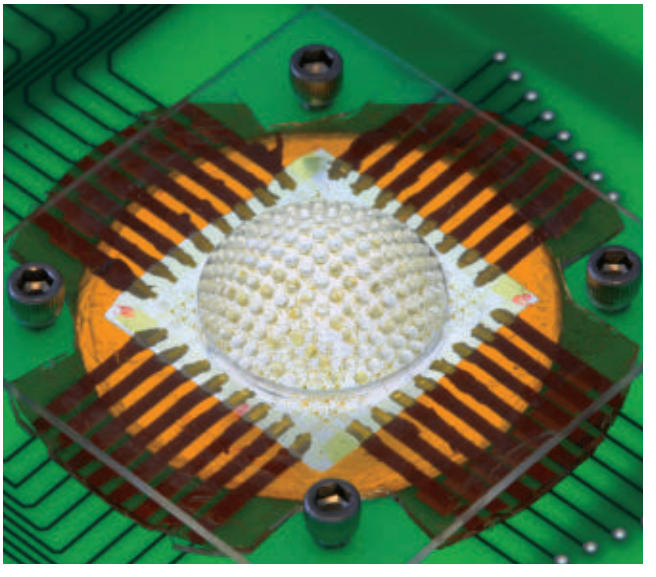
Wood notes a key limitation, however: The robots don't have on-board power, sensors or controls, so they always have to be plugged in.

And Dickinson points out that the wings' flapping motion isn't as sophisticated as that of real flies. Wood's team and other researchers are working to address each of these concerns.

"It's a very impressive step forward," Dickinson says. "But it also indicates how far engineers will have to go before they have a truly autonomous fly robot."

Mimicking the fly's eye

A new digital camera may change the meaning of bug-eyed. Inspired by the compound eyes of certain ants, beetles and flies, engineers have developed a digital camera that, using 180 tiny lenses, is capable of panoramic views. Such cameras might soon bedeck tiny flying robots that could scour a disaster site for survivors or conduct other aerial surveillance. Light striking the new camera passes through 180 lenses embedded in a curved rubber device (shown) about the size of a dime. The lenses guide the light to detectors at the camera's back. Constructing the camera is relatively straightforward and doesn't require special materials, the team reports May 2 in *Nature*. While the lenses on the current version approximate the relatively low resolution achieved by the tiny eye of the thief ant (*Solenopsis molesta*), the 26,000 lenses of a dragonfly eye should be doable, says study coauthor John Rogers of the University of Illinois at Urbana–Champaign. — *Rachel Ehrenberg*



FROM TOP: KEVIN MA AND P. CHIRARATTANANON, UNIV. OF ILLINOIS AND BECKMAN INSTITUTE

News in Brief

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EARTH

2011 quake boosted Tokyo's seismic risk

The magnitude 9 earthquake that shook Japan in March 2011 more than doubled the risk that a big quake will rattle Tokyo in the next five years, geologists report May 2 in *Geophysical Research Letters*. The 2011 quake hit 373 kilometers northeast of Tokyo. Afterwards, seismic activity around Japan's capital spiked, and small earthquakes are now three times as frequent as they were before the event. The ground movement comes from a piece of Earth's crust that's wedged between the Eurasian plate, on which Tokyo sits, and the Pacific plate, which slides into the mantle beneath the Eurasian plate. Shinji Toda of Tohoku University in Japan and Ross Stein of the U.S. Geological Survey in Menlo Park, Calif., suggest that the 2011 quake transferred stress to the wedged fragment, triggering the increase in seismic activity. The pair calculates that the added stress raises the probability of a magnitude 7 or larger earthquake striking Tokyo in the next five years from 6.6 percent to 17.2 percent. —*Erin Wayman*

Atmospheric CO_2 hits milestone

On May 9, the atmosphere above Hawaii's Mauna Loa volcano reached a milestone: For the first time since record keeping began there in 1958, the daily mean carbon dioxide concentration hit 400 parts per million. The Mauna Loa Observatory provides the world's longest-running record of atmospheric CO_2 concentration. The last time Earth's global CO_2 concentration was as high was during the Pliocene epoch, 5.3 million to 2.6 million years ago, when summers in the Arctic were 8 degrees Celsius warmer than they are today. CO_2 levels have risen sharply since the beginning of the Industrial Revolution, when the global average was 280 ppm. —*Erin Wayman*

GENES & CELLS

Gut bacteria get cozy in bladder

The culprits in recurrent urinary tract infections may be hardy strains of *E. coli* that readily hop from gut to bladder, scientists report in the May 8 *Science Translational Medicine*. By monitoring levels of microbes in the gut, doctors might be able to catch the bacteria before they travel to the urinary tract, the team suggests. Scientists already knew that gut bacteria colonizing the bladder adapt to their new environment, using sticky nubs to cling to the organ's walls and taking cover from antibiotics by clumping together and ducking inside cells. But researchers thought these lifestyle tweaks would prevent the bacteria from returning to life in the gut. By analyzing urine and fecal matter from four women with recurrent urinary tract infections, Jeffrey Gordon of Washington University in St. Louis and colleagues found that the same bacteria could survive in both the gut and the bladder. A closer look at one such bug revealed that the strain excelled at finding food in both places and had the equipment to attach to and travel between locations. —*Meghan Rosen*

HEALTH & ILLNESS

Some at-risk kids can access guns

Roughly one-sixth of children deemed at risk of suicide say that there are firearms at home, a study in urban areas finds. Stephen Teach, a pediatric emergency medicine physician at Children's National Medical Center in Washington, D.C., and his colleagues analyzed responses collected from 524 children and adolescents interviewed at several urban hospital emergency rooms in the United States. Of the patients, 180 were in the ER with psychiatric complaints and 344 for other reasons. Overall, 151 children were deemed at risk of suicide by a doctor after answering yes to one of four questions: Have you ever tried suicide, felt your family would be better off without you, had thoughts about suicide in the past week, or wished you were dead in the past week? While 65 percent of the children getting a psychiatric assessment answered yes to at least one question, so did nearly 10 percent of children examined for other problems. Twenty-six of the 151 at-risk kids said there were firearms at home, Teach reported on May 6 in Washington, D.C., at a meeting of the Pediatric Academic Societies. Emergency room doctors "are in a unique position to reduce access to firearms," Teach said, by assessing kids' risk and talking with parents. —*Nathan Seppa*

Maximizing umbilical benefits for preemies

A newborn's umbilical cord is typically clamped immediately, severing it as a conduit from mother to baby. Researchers now find that for very preterm infants, keeping the cord unclamped shortly after birth and squeezing it with a few long strokes from mother toward the child delivers valuable blood to the infant. The process—called milking—appears to benefit these babies. Neonatologist Anup Katheria of the University of California, San Diego and colleagues randomly assigned 60 babies born an average of 11 weeks premature to get either standard treatment or to receive milking with three strokes, a process that takes less than a minute. Measurements conducted six, 18 and 30 hours after birth showed that those who received the extra cord contents had greater blood flow and were less likely to need a blood transfusion or oxygen. Katheria, who reported the findings on May 6 at a Washington, D.C., meeting of the Pediatric Academic Societies, said that milking the cord seems to deliver more blood and might dislodge and deliver to the infant valuable stem cells that line the inside of the cord. The study is the largest randomized trial to test the procedure, Katheria said. —*Nathan Seppa*

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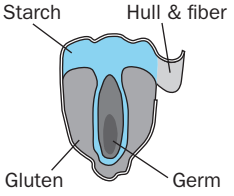
Sweet Confusion

Does high fructose corn syrup deserve such a bad rap?

By Laura Beil

When chemists Richard Marshall and Earl Kooi started fiddling with cornstarch, the powder made from the dense insides of corn kernels, their intention was to turn glucose, which is easily produced from the starch, into fructose, which is sweeter. The idea wasn't that far-fetched. The two sugar molecules are cousins, both made from the same atomic parts slightly rearranged.

The duo's experiment, which took place at the Corn Projects Refining Company in Argo, Ill., was a success. Marshall and Kooi discovered that the bacterium *Aeromonas hydrophila* produced an enzyme that could reconfigure the components of glucose from corn like so many Lego blocks. It was the first leap forward for a food industry dream: a mass-produced glucose-fructose-blend sweetener that would free commercial food manufacturers from the historical volatility of cane sugar crops.



Where it begins The starch component of the corn kernel yields glucose, which is processed into fructose.

The scientists announced their triumph in a short report in *Science* in 1957. There the discovery sat in quiet obscurity for almost two decades, until a worldwide spike in sugar prices sent manufacturers scrambling. By the end of the 1980s, high fructose corn syrup had replaced cane sugar in soft drinks, and it soon became popular among makers of baked goods, dairy products, sauces and other foods.

Few consumers seemed to care until 2004, when Barry Popkin, a nutrition scientist at the University of North Carolina at Chapel Hill, along with George Bray, at the Pennington Biomedical Research Center in Baton Rouge, La., published a commentary in the *American Journal of Clinical Nutrition* pointing out that the country's obesity crisis appeared to rise in tandem with the embrace of high fructose corn syrup by food producers. That shift began in the early 1970s — just about the time Japanese researchers, who had noted Marshall and Kooi's experiment with keen interest, overcame the technical hurdles of industrial production.

Popkin's paper was far from an indictment of high fructose corn syrup. It offered only the weakest kind of evidence — a provocative correlation and a graph (see next page) showing an eerily similar upward trajectory for both obesity and the preference for high fructose corn syrup over sucrose, or table sugar. "The original article actually was a scientific speculation saying we need research," Popkin says.

What he didn't anticipate was the birth of blogging, which catapulted his theory across the digital universe.

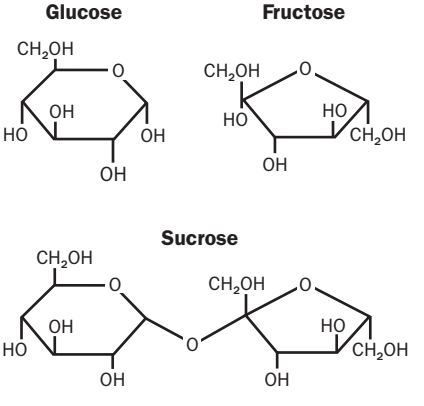
Much of what has emerged since then has kept bloggers well supplied and turned high fructose corn syrup into a dietary boogeyman. Excessive fructose is cited as an accomplice in the twin epidemics of obesity and diabetes, and among the constellation of risk factors (including abdominal fat, high blood pressure and elevated triglycerides) that produce the dangerous condition known as metabolic syndrome. Further damaging are studies suggesting that once in the body, fructose is more likely to take up residence as fat around the belly and less likely to engage the appetite-control mechanisms that help put the brakes on eating. The story gets worse: In addition to the consequences for American waistlines, data also point to unique threats to the kidneys, liver and other organs.

Yet some caution that public opinion has gotten ahead of science and that fructose tunnel vision may distract us from the complex causes of the country's obesity crisis. Having a corn-based bad guy in the crosshairs has been an advertising boon for the sugar industry, Popkin says. The phrase on food labels that says "made with natural sugar" is popularly interpreted as "healthier," as is "no high fructose corn syrup." In truth, the consumption of high fructose corn syrup has been falling since 2004. Yet obesity rates remain high.

Fructose turns sour

Perhaps chief among the concerns over fructose are its effects on the liver, which is the first stop after sugar leaves the intestine. The liver either absorbs sugar or allows it to pass into the bloodstream to be turned into energy for the brain, muscles and other organs. But it matters what kind of sugar it is. Table sugar, or sucrose, is a bound dimer of glucose and fructose, which means the two sugar

Ties that bind — or don't High fructose corn syrup is made from a mix of fructose and glucose, the same chemical components that are bound together in sucrose, or table sugar.



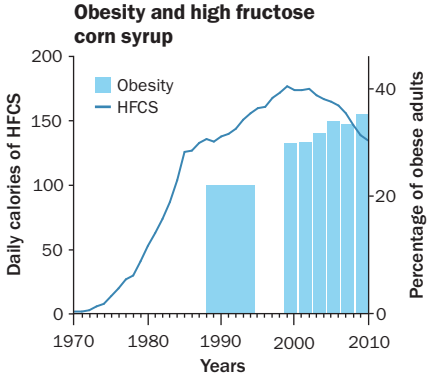
OPPOSITE PAGE: CAROLYN SEWELL; THIS PAGE: M. ATAROD

molecules are locked arm in arm until broken apart by the intestine. In high fructose corn syrup, fructose and glucose are not chemically bound. (The ratio of fructose to glucose depends on the type of corn syrup: the kind typically used in soda is 55 percent fructose and 42 percent glucose. Other types have more glucose and less fructose.) An enzyme called phosphofructokinase acts as a kind of thermostat to detect whether the liver needs fuel. If it doesn't, glucose moves into the blood straightaway.

But fructose seeps into the liver whether or not the energy is needed. This is a major concern to scientists like Kimber Stanhope, a molecular biologist at the University of California, Davis. "The enzyme that controls fructose metabolism is fructose kinase," she says. "It appears to be almost always turned on." Unless you are energy depleted, really starved of calories that the rest of the body needs, "when you consume fructose, it all goes to the liver," says Robert Lustig, a pediatric endocrinologist at UC San Francisco who has become one of the most outspoken critics of added sugar, and especially of fructose. This flood of energy makes its way to the mitochondria, which are the power plants of a cell. "When your mitochondria get overloaded, the excess energy is turned into liver fat," Lustig says. In a paper this year in *Advances in Nutrition,* he characterized fructose as "alcohol without the buzz," because of its potential to cause liver damage.

Looking for a link For decades obesity in American adults over 20 was on the rise along with consumption of HFCS, high fructose corn syrup. But in the last decade, consumption has dropped while obesity has not.

SOURCE: NCHS (OBESITY); USDA, ERS (HFCS)



Once in the liver, some fructose may wind up packaged for short-term storage as glycogen or for long-term storage as fat. Fructose encourages the liver to increase production of uric acid, a metabolic end product that is best known for causing gout, but which is also a risk factor for high blood pressure and kidney disease. Studies in animals — and more recent research in humans — raise the possibility that when compared with similar intakes of other beverages, drinks with high fructose corn syrup may promote fatty liver disease (often a consequence of alcoholism) and raise levels of triglycerides, fat molecules that circulate in the bloodstream. High triglycerides are a risk factor in heart disease.

In 2009, Stanhope and her colleagues reported in the *Journal of Clinical Investigation* that among volunteers who consumed beverages sweetened with either glucose or fructose, those who drank fructose experienced significantly higher accumulations of fat within the abdomen, even though both groups gained about the same amount of weight. And while this experiment found that glucose was more likely than fructose to raise triglyceride levels, a subsequent study found just the opposite. In 2011, in the *Journal of Clinical Endocrinology and Metabolism*, Stanhope reported that volunteers who drank beverages with high fructose corn syrup experienced a rise in triglycerides during the day that was almost twice as high as that produced by glucose.

In October 2012, writing in *PLOS ONE,* researchers from the University of Colorado Denver, with others, added another dimension to the story of fructose metabolism, describing evidence that in liver cells uric acid can accelerate the metabolism of fructose to fat. If the finding holds up in further work, it might help explain why some people appear more sensitive to the effects of fructose — uric acid levels vary from person to person.

Concerns about fructose also extend to influences on overall body weight, based on evidence that normal appetite controls do not engage as they should after an influx of calories from fructose. One of the latest studies appeared in January in the *Journal of the American Medical Association.* A team of researchers from Yale University and elsewhere performed fMRI scans on healthy young adults after the subjects drank liquids containing either glucose or fructose. They found that blood flow to regions of the brain that control appetite decreased after drinking glucose but not fructose, suggesting that fructose has a weaker impact on appetite.

Fructose may also affect diabetes risk. Though insulin levels remain relatively unperturbed by fructose, there are indications that fructose, even more than glucose, can lead to insulin resistance. (Such resistance is caused when the body loses sensitivity to insulin, prompting the pancreas to work harder to pump out higher and higher amounts of the hormone.) A trial comparing insulin sensitivity in young men after consuming either glucose, fructose or sucrose appeared in January in *Diabetes Care.* Sucrose and fructose, even in moderate amounts, rendered insulin less potent.

Science gets sticky

While individual studies can make a damning case against fructose, it's not so easy to reach a verdict when the evidence is considered as a whole, says John Sievenpiper, a nutrition researcher at St. Michael's Hospital in Toronto. People are not only consuming more calories from fructose, they are consuming more calories period. Weight gain alone poses serious health risks, Sievenpiper and others point out, regardless of where the extra calories come from.

Over the last few years, Sievenpiper has published several studies that compile the body of work on fructose into a sweeping analysis. This is the only way to get a true sense of the health effects, he contends, and the danger he's found so far is underwhelming. Although his recent fructose studies were funded by the Canadian government, Sievenpiper

M. ATAROD

readily reveals that he has received unrestricted research grants from the beverage industry. Still, he says, "My frame of mind going in, to be honest with you, was that we were going to find a signal for harm because of the biochemistry."

That has not been the case. In February 2012, in the *Annals of Internal Medicine,* he and his coauthors tallied 41 human feeding studies that examine whether fructose is more likely to lead to weight gain than other forms of carbohydrates. The result: When people eat the same number of calories of any carbohydrate, "it doesn't look like the fructose is behaving differently," he says. But when volunteers consume more energy from fructose than they burn, the sugar does appear to cause weight gain. It's hard to tell, however, whether that's because of the fructose or just the overabundance of calories, Sievenpiper says.

Other researchers point out that many experiments finding reason for concern about fructose have been conducted in animals. Or studies compare intake of pure glucose and pure fructose, neither of which is what's in a soda bottle. "If fructose is really causing a problem, demonstrate it in physiological or real-world diets," says John White, a former corn industry researcher who is now a consultant. He says he would like to see a study that examines high fructose corn syrup the way most people consume it. "Do that experiment, and publish it, and prove to us that it's a problem," White says. He also points out that the graph published by Popkin and Bray, when plotted today, does not show the correlation it did in 2004. "High fructose corn syrup has been in decline now for 14 years," White says. "What's happened to obesity rates? They've continued to climb."

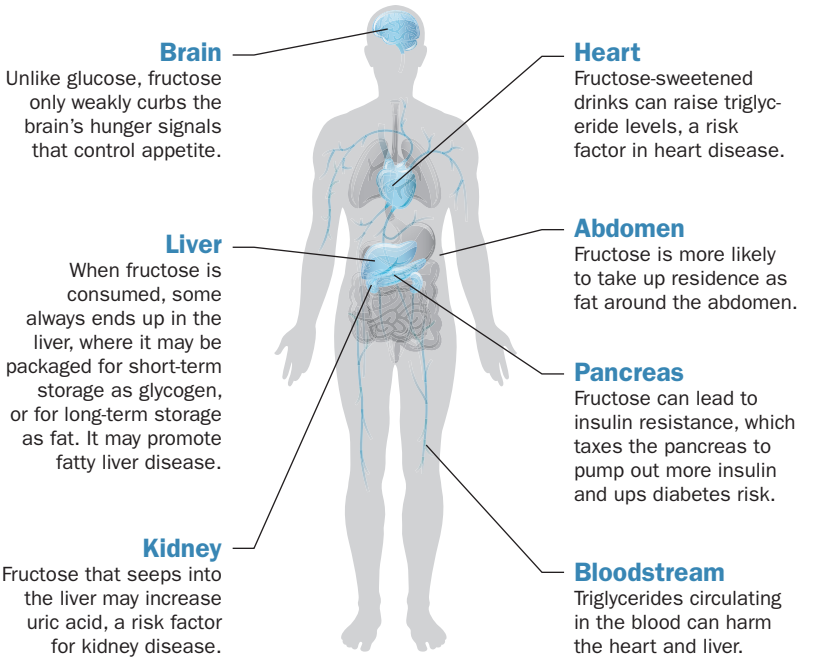
Fructose could pose a particular harm—but not for everyone at the same dose, says Miriam Vos, a pediatric liver specialist at Emory University School of Medicine. Just as certain people are more susceptible, probably because of genetics, to the effects of salt on blood pressure or tobacco on cancer risk, some may be more sensitive to the biochemical complications of fructose. Last year in the *Journal of Clinical Endocrinology and Metabolism,* Vos reported that fructose raised triglyceride levels in teenagers with fatty liver disease more than in healthy teens, even when they consumed the same number of calories. "My impression is that fructose alone would not cause fatty liver disease in someone who is not susceptible," she says.

The focus on fructose has been scientifically beneficial, but Vos worries that one unintended consequence has been to make other sweeteners look good by comparison. Sucrose and high fructose corn syrup are both made of glucose and fructose. "From a public health standpoint, it may be less important which half of the sugar is causing the problem, because first of all, maybe it's both together, and then second of all, maybe the real question is, what's a safe dose? Not which half is safer," she says. "Because no one is going to advocate for a pure glucose drink."

The bigger problem may be that Americans have developed too much of a sweet tooth for their own health. A 2012 study from Popkin in the *Journal of the Academy of Nutrition and Dietetics* found that 75 percent of packaged foods and beverages contain added sweetener, and plain old corn syrup (not the high fructose version) was the most common. High fructose corn syrup was invented to make sweet foods cheaper, Lustig says. It is not only cheap, but stable in foods, and easy to transport and store because it is a liquid. Once it became widely available, companies that previously did not sweeten their foods so much were able to because they could afford to, he says.

Today many manufacturers are returning to natural sugar or fruit-juice concentrate, knowing that fructose-wary consumers are scrutinizing labels. But Vos wonders if this is truly public health progress. "If you replaced all of the high fructose corn syrup with cane sugar, would we be better off?" she asks. "No. We would be exactly in the same place." ■

Effects of fructose The science hasn't settled whether high fructose corn syrup has more damaging overall effects on the human body—or on the ongoing obesity crisis—than table sugar. But there is evidence of the effects that fructose has on various organs and systems.



Explore more

- G. Bray and B. Popkin. Calorie-sweetened beverages and fructose: what we have learned 10 years later. *Pediatric Obesity.* 2013.

FILO/ISTOCKPHOTO AND COMPOSITE

CLOSED THINKING

Without scientific competition and open debate, much psychology research goes nowhere

By Bruce Bower

In its idealized form, science resembles a championship boxing match. Theories square off, each vying for the gold belt engraved with "Truth." Under the stern eyes of a host of referees, one theory triumphs by best explaining available evidence — at least until the next bout.

But in the real world, science often works more like a fashion show. Researchers clothe plausible explanations of experimental findings in glittery statistical suits and gowns. These gussied-up hypotheses charm journal editors and attract media coverage with carefully orchestrated runway struts, never having to battle competitors.

Then there's psychology. Even more than other social scientists — and certainly more than physical scientists — psychologists tend to overlook or dismiss hypotheses that might topple their own, says Klaus Fiedler of the University of Heidelberg in Germany. They explain experimental findings with ambiguous terms that make no testable predictions at all; they build careers on theories that have never bested a competitor in a fair scientific fight. In many cases, no one knows or bothers to check how much common ground one theory

JAMES PORTO/GETTY IMAGES, JAMES GROUP STUDIOS/ISTOCKPHOTO, ADAPTED BY S. EGTS

shares with others that address the same topic. Problems like these, Fiedler and his colleagues contended last November in *Perspectives in Psychological Science,* afflict sets of related theories about such psychological phenomena as memory and decision making. In the end, that affects how well these phenomena are understood.

Fiedler's critique comes at a time when psychologists are making a well-publicized effort to clean up their research procedures, as described in several reports published alongside his paper. In fact, researchers generally concede that many published psychology studies have been conducted in ways that conceal their statistical frailty — and thus the validity of their conclusions. But Fiedler suspects the new push to sanitize psychology's statistical house won't make much difference in the long run. Findings published in big-time journals draw enough media coverage to bring the scrutiny of other researchers, who eventually expose bogus and overblown effects. "Advances in psychology will depend more on open-minded theoretical thinking than on better monitoring of statistical practices," he says.

Psychologists tend to overlook or dismiss hypotheses that might topple their own.

Alternative blindness

When Fiedler gives talks to groups of psychologists, he tries to identify open-minded theoretical thinkers by posing a couple of questions.

First, he asks audience members to name a published study in which investigators uncovered an interesting, statistically significant effect that vanished in later reports. In a seminar conducted last year by Fiedler at a major Dutch university, 38 research psychologists had no problem citing flash-in-the-pan findings. Many remembered a well-known but now contested report that college students react to subtle reminders of old age by walking more slowly, allegedly because healthy young people unconsciously act out prompted stereotypes of the elderly *(SN: 5/19/12, p. 26)*.

In that experiment, student volunteers were timed walking down a corridor after unscrambling sentences that, for one group, contained senior citizen–related words such as *wrinkle* and *Florida*. Researchers who conducted the investigation concluded that students weren't aware of having registered the stereotypical words, but still acted out an elderly stereotype by slowing their pace shortly after the reading exercise.

But researchers did not consider the possibility that their facial expressions or body language might subtly have encouraged the student volunteers to walk more slowly. They didn't ask themselves whether some students noticed elder-related words while unscrambling sentences and supposed that experimenters *wanted* them to mimic seniors. They did not explore whether some students quickly drew conclusions about what was expected of them and how to behave, regardless of any unintended signals from experimenters. Nor did they examine whether reading words related to any upsetting or thought-provoking topic would make people walk more slowly.

Fiedler's point: Blindness to additional, possibly superior, explanations for experimental results plagues even prominent psychological theories. "Psychologists too often fail to consider that the truth may be broader than their hypotheses," says psychologist Barbara Spellman of the University of Virginia in Charlottesville. Spellman edits the journal *Perspectives in Psychological Science,* in which Fiedler's article appears.

And indeed, as in other seminars Fiedler has run, only a few of the psychologists at the Dutch seminar came up with anything when they were asked to name an experiment that included a competing account for any set of results.

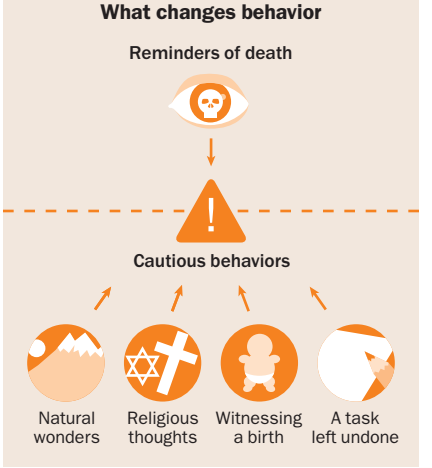
Null and void

Geoffrey Loftus, a psychologist at the University of Washington in Seattle, is an ally in Fiedler's battle to broaden psychology's perspectives. As editor of *Memory & Cognition* from 1993 to 1997, Loftus implored researchers to avoid a standard statistical practice in psychology known as null hypothesis significance testing that, in his view, perpetuates theoretical chaos. He continued to attack the practice in a talk last November at the Psychonomic Society's annual meeting in Minneapolis.

Null hypothesis refers to a default position: that there is no relationship except chance between two measured phenomena in an experiment (for example, it's only by chance that college students walk at different speeds after they've read words that refer to old age). To conclude that there *are* grounds to say that a relationship exists between two phenomena, the null hypotheses must be rejected. This technique requires researchers to calculate whether an assumption that no experimental effect exists can be rejected as statistically unlikely based on measured differences between groups.

This is a statistical charade, Loftus contends, since measures taken before and after any test are virtually never the same. Rejecting a null hypothesis doesn't tell a researcher anything new,

A difference in behavior One psychological theory proposes that symbols of death make individuals aware of their own mortality and lead them to adopt more cautious behaviors. Klaus Fiedler suggests that many other factors (bottom) might also cause self-awareness and similarly conservative behaviors.



S. EGTS

No swapping Psychologist Walter Mischel suggests that psychologists often operate in isolation without trying to integrate related theories: "Psychologists treat other people's theories like toothbrushes—no self-respecting person wants to use anyone else's."

even if the threat of finding an effect that doesn't really exist has been eliminated. "Significance testing is all about how the world isn't," Loftus contends, "and says nothing about how the world is."

The art of theory construction in psychology has withered during the field's 50-year romance with null hypothesis significance testing, asserts psychologist Gerd Gigerenzer of the Max Planck Institute for Human Development in Berlin: "The problem is not that researchers think that theory is irrelevant, but that almost anything passes as a theory."

Researchers clothe plausible explanations in glittery statistical suits and gowns.

Gigerenzer has identified three types of theory substitutes in psychology. Each surrogate for theory is so vague and prediction-free that it can't be proven wrong.

First, Gigerenzer says, investigators sometimes explain their findings by using a term for a theory that can be construed to explain not only an observed effect but also its opposite. Consider "representativeness," which many decision researchers use to explain gamblers' frequent intuition that, after landing on a series of red spaces on a roulette table, they're going to land on a black space. In this case, psychologists interpret representativeness to mean that people assume that random sequences of two outcomes are best represented by a short sequence containing both: reds and blacks when playing roulette, or heads and tails when flipping a coin.

Yet investigators have also used representativeness to explain the opposite intuition, in which people assume that a streak of outcomes is likely to continue. Sports fans demonstrate this kind of intuition when they attribute "hot hands" to basketball players who make several shots in a row *(SN: 2/12/11, p. 26)*. The fans expect the players to sink their next try. In this case, representativeness is interpreted to mean that people regard a run of scores as characteristic of a larger random sequence containing streaks of scores and misses.

Another theory-avoiding tactic consists of describing a finding without trying to explain it, Gigerenzer says. The phrase "inequality aversion" has been applied in some studies to describe the willingness of subjects to divide a pot of money equally rather than to find some other way to divide it. Inequality aversion addresses how participants behaved, but it makes no prediction about *why* they behaved that way.

Perhaps the most popular theory surrogates are two-system theories. Many psychologists now assume that we make decisions using two mental systems: System 1, in which we make quick, intuitive decisions based on fallible rules of thumb, and System 2, in which we make logical, deliberate choices that require more time and brain power. Psychologist Daniel Kahneman of Princeton University, a Nobel laureate in economics, has done the most to popularize the System 1/System 2 distinction.

Gigerenzer contends that almost any behavior in a decision-making study can be attributed to either System 1 or System 2. In the January 2011 *Psychological Review,* he and psychologist Arie Kruglanski of the University of Maryland in College Park argued that intuitive and deliberate judgments alike are based on shared rules of thumb, or heuristics. Many parents intuitively allocate attention and love equally to all of their children, for instance, and many investors deliberately follow the same simple rule by allocating money equally to all of their chosen stocks to reduce risk *(SN: 6/4/11, p. 26)*.

Dividing the mind into a nebulous split between intuitive heuristics and logical rule-following distracts scientists from exploring how heuristics operate in both intuitive and deliberative ways and in what situations heuristics work best, Gigerenzer argues.

Toothbrush culture

None of this is to say that psychology has no genuine theories, but many of them exist in splendid isolation. Most psychologists work in narrow communities, such as developmental psychology and social psychology, where established theories are rarely challenged. As a quotation cited in 2008 by psychologist Walter Mischel of Columbia University in New York City puts it, "Psychologists treat other people's theories like toothbrushes—no self-respecting person wants to use anyone else's." That kind of professional isolationism leads to "theoretical disorganization," write Eli Finkel of Northwestern University in Evanston, Ill., and Paul Eastwick of the University of Texas at Austin.

In a chapter in an upcoming book, Finkel and Eastwick discuss theories about how men and women are attracted

LETIZIA MCCALL/GETTY IMAGES

to each other. One popular theory holds that people are attracted to others who satisfy general needs for pleasure, belonging and a few other social prizes. A second approach posits that people have evolved certain types of mating strategies over the past few million years. A third perspective assumes that individuals form relationship styles early in life with parents and others that orchestrate choices of romantic partners decades later.

Finkel and Eastwick propose that all three approaches can be organized around a principle, developed in related research, that attraction depends on how well one person enables another to achieve urgent goals for pleasure, reproduction, a good relationship fit — or anything else. Research grounded in that principle has the potential to produce a unified theory of attraction.

Opportunities to unify related theories often arise when scientists from different disciplines collaborate on studies of broad topics such as decision making or moral behavior, Gigerenzer says. He heads a team of scientists with backgrounds ranging from ecology to economics that studies heuristic reasoning. Members of this group have found commonalities between a complex model of thinking and decision making developed by psychologist John Anderson of Carnegie Mellon University in Pittsburgh and a simple decision-making rule that is surprisingly effective in certain situations.

The rule goes like this: If an experimental subject is asked to make a choice where one of two options is recognized, the subject will pick the familiar item. In studies of German and U.S. students, each group did better at identifying the larger city from pairs of choices in foreign countries than from pairs in their homelands. Partial ignorance about foreign cities led the students to choose the most familiar city. Since better-known cities tend to be especially large ones, the students' simple tactic worked surprisingly well. Recognition-guided choices weren't an option for pairs of familiar cities in students' native lands.

Full disclosure

For decades, popular research tools, from statistical methods to computers, have been proposed as models of how people think. Once a research tool gains traction as a theory of the mind — say, the notion of the mind as an information-processing computer — creative thinking about alternative theories becomes increasingly difficult, Gigerenzer says.

That may be so, but psychologist Uri Simonsohn of the University of Pennsylvania in Philadelphia believes that the researchers' efforts to upgrade statistical practices can coexist with hypothesis competition and theory integration.

In a 2011 paper in *Psychological Science* that has become a manifesto for those aiming to minimize published results that vanish on closer inspection, Simonsohn and his colleagues recommended ways to discourage researchers from cherry-picking data to include in final reports, altering experimental conditions that don't work as planned and using other tactics that disguise statistical weakness.

Some researchers propose using a statistical technique known as Bayesian analysis that estimates which of several hypotheses best explains a set of results. But despite the strengths of Bayesian statistics, investigators can still exclude inconvenient data or hypotheses from this approach, Simonsohn holds.

In the end, no statistical procedure can thrust psychological research into the championship ring, where losses sting but unexpected wins reap big rewards, Fiedler says. In scientific cultures that encourage clear predictions and open debate, even vanquished predictions get respect for having helped to advance knowledge.

"It is a good morning exercise for a research scientist to discard a pet hypothesis every day before breakfast," the late ethologist Konrad Lorenz wrote. "It keeps him young." ■

Explore more:

- P. Van Lange *et al. Handbook of theories of social psychology.* SAGE. 2011.

KARL KRALL/WIKIMEDIA COMMONS

The lesson of Clever Hans

Any scientist will admit that unconscious cuing by an experimenter can introduce bias into testing. A German named William von Osten and his horse Hans unwittingly demonstrated that — and inspired the term Clever Hans effect. Von Osten became famous in 1891 for public displays of Hans' ability to perform mathematical calculations and other feats by tapping his hoof. No cheating was apparent, but in 1907 psychologist Oskar Pfungst investigated claims about Hans' intelligence. Pfungst had different experimenters ask questions standing at varying distances from Hans. Sometimes Hans wore blinders; sometimes the experimenters knew the answers to their own questions and sometimes they didn't. Pfungst discovered not only that Hans needed visual contact with the questioner but also that Hans couldn't answer a question when the experimenter didn't know the answer. Conclusion: Although questioners were not consciously cuing Hans to start or stop tapping, their facial expressions or involuntary movements were enough for Clever Hans to catch on. — *Bruce Bower*

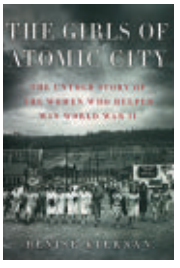
The Girls of Atomic City

Denise Kiernan

In late 1942, less than a year after Pearl Harbor, the U.S. government began snapping up property in eastern Tennessee. Within a matter of months, approximately 59,000 acres of farms and orchards, homesteads and hovels just south of the Black Oak Ridge hosted immense construction sites that became the home of supersecret facilities used to enrich uranium for the Manhattan Project. Kiernan chronicles the fascinating lives of some of the young women who lived and worked in this fenced-in town, helping to develop the first atomic bombs.

At its wartime peak, the largely self-contained Oak Ridge community housed about 75,000 people but used more electricity than New York City.

It employed a diverse workforce that included janitors, administrators, chemists and statisticians, many of them female because men were off at war. But unlike Rosie the Riveter, who could actually see the items she helped manufacture rolling off the assembly lines, few if any of the women of Oak Ridge knew how they were helping the war effort. To preserve that secrecy, recruiters hired many of these women fresh out of high school — mostly because, at the time, young ladies in the workplace were expected to do what they were told and not to ask a lot of questions.



Brief chapters provide vital context into the technical aspects of uranium enrichment, as well as the progress taking place at other Manhattan Project sites. But the most interesting parts of this history deal with the social aspects of life in a bustling community so rife with secrecy that the local paper didn't print the names of residents in its articles.

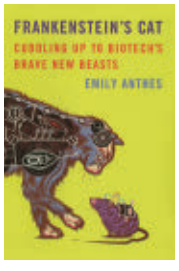
— Sid Perkins

Touchstone, 2013, 373 p., $27

Frankenstein's Cat: Cuddling Up to Biotech's Brave New Beasts

Emily Anthes

Artemis may look like any other goat, but a little human DNA inserted into her genetic code gives her life-saving potential. This University of California, Davis wonder produces milk rich in the bacteria-busting enzyme lysozyme, a compound that could help prevent some of the hundreds of thousands of deaths from diarrhea worldwide each year.



"Science has given us a whole new toolbox for tinkering with life," writes journalist Anthes. *Frankenstein's Cat* shows off just a small sampling of this humanmade (or at least human-modified) menagerie. Some, like Artemis, are the result of genetic editing. Others are biomechanical: Anthes meets scientists who have wired insects' brains to steer them like remote-controlled cars and others who built a prosthetic tail for a wounded dolphin.

People don't always embrace these Frankenanimals. Just ask AquaBounty, a Massachusetts-based firm that's been trying to get its fast-growing genetically modified salmon onto American dinner plates for more than 15 years. And it's tough to share Anthes' gee-whiz enthusiasm when some of the proposed projects seem like Band-Aids to fix bad human behavior. Cloning species on the brink of extinction, for instance, will do little good if their habitats are now housing developments.

Still, Anthes does an admirable job addressing the thorny ethical issues behind altering animals' bodies and minds, whether mechanically or genetically. "Biotechnology is not inherently good or bad; it is simply a set of techniques," she writes, "and we have choices about how we employ them."

— Allison Bohac

Scientific American/Farrar, Straus and Giroux, 2013, 241 p., $26

Fatal Flaws

Jay Ingram

Learn how scientists discovered misshapen proteins called prions and found that these agents cause mad cow and other neurological diseases. *Yale Univ., 2013, 282 p., $30*

Robot Futures

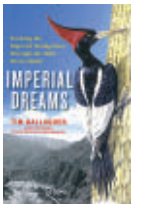
Illah Reza Nourbakhsh

A robotics professor ponders the societal implications of living with robots as part of daily life and offers a vision for a harmonious future. *MIT, 2013, 133 p., $24.95*

The World's Rarest Birds

Erik Hirschfeld, Andy Swash and Robert Still

This guide, filled with photos and descriptions of conservation efforts, illustrates the perils faced by rare and endangered avian species. *Princeton Univ., 2013, 360 p., $45*



Imperial Dreams

Tim Gallagher

A naturalist dodges drug traffickers and other dangers in Mexico while searching for the imperial woodpecker, last seen in 1956. *Atria, 2013, 277 p., $26*

Are We Being Watched?

Paul Murdin

An astronomer looks at how and where life may have emerged and whether Earthlings are alone in the universe. *Thames & Hudson, 2013, 224 p., $24.95*

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Fusion reactions

It is not true that fusion packs the highest punch of any known energy-generating process ("Ignition failed," *SN: 4/20/13, p. 26*). Matter-antimatter annihilation far exceeds it (*Star Trek* had it right back in the 1960s). I believe that under certain conditions, matter falling into a black hole can also yield more energy than fusion.
Bobby Baum, Bethesda, Md.

The reader is right on both counts. But those approaches are impractical. Scientists have harnessed energy from fusion, even if it has not produced net energy. Energy has never been harnessed from matter-antimatter, and certainly never from a black hole. —Andrew Grant

The bigger problems [with fusion] are cost and size. It has been known since the 1970s that a successful tokamak machine would be so large and complex that the cost of its electrical output would be an order of magnitude more expensive than the power from the most expensive fission reactor. Moreover, fusion plants would produce radioactive waste. The structural steel would not be as dangerous as spent fuel rods, but it would constitute a low level waste. Fusion research has wasted the entire professional lives of literally thousands of brilliant physicists. It should be shut down.
Robert Sykes, via e-mail

"Conventional" fusion reactions produce copious amounts of neutrons, which are quite radioactive and, if not themselves "waste" in the sense that most people might picture, cause severe radiation damage to the structures of which the fusion reactor itself is built. Those structures then have to be disposed of and replaced. I'd call that radioactive waste, and it's inescapable with conventional fusion reactions.
Roger Stout, Phoenix, Ariz.

Fusion does produce neutrons, which degrade structures and can cause radioactivity. But unlike fission, fusion doesn't produce waste that needs to be stored in casks or buried under a mountain. Plus, fusion power plants could never have a nuclear meltdown that would contaminate a large area, as Chernobyl and Fukushima did. —Andrew Grant

Correction

"Fossil embryos offer glimpse at dinosaur growth" (*SN: 5/4/13, p. 5*) incorrectly stated that recently analyzed dinosaur fossils may contain "some of the oldest preserved organic remains found." Older remains, such as archaea preserved in stromatolites, also contain organic matter. The new finds may be the oldest organic remains found for a land-dwelling vertebrate.

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The Science Life

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Entomologist Michael Raupp says this year's cicada emergence will give scientists and bug lovers a good chance to study the insects.

Embracing the swarm

Entomologist Michael Raupp is enjoying Swarmageddon. The giant batch of cicadas began emerging from the ground in late April and will be heard in some northeastern states through June.

"You see the insects in a mad, desperate dash for the trees so they can survive and mate," Raupp says. "Birds and squirrels will be eating them. It's life, it's death, it's romance. It's a massive display of Mother Nature's wonder—in my opinion, at its best."

Likewise, scientists get only so many chances to study each cohort, or brood, of cicadas. This particular cycle of 17-year cicadas is called Brood II and occurs from northern North Carolina to Connecticut and New York's Hudson River Valley.

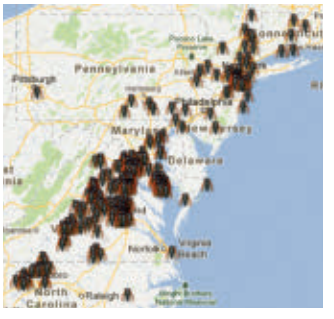
Raupp, a cicada expert at the University of Maryland in College Park, is tracking the emergence of cicadas in several locations in Maryland and New Jersey, adding to a growing database collected by scientists and citizens (see sidebar, right). He is watching the behaviors of immature cicadas, called nymphs, as they prepare to emerge from the soil and is also studying adults' escape behaviors. Cicadas are not known for great predator-avoidance skills, perhaps relying on their infrequent appearances in huge numbers to sustain the species. "There's safety in numbers," Raupp says.

This year's cicadas belong to the genus *Magicicada*, which includes broods emerging every 13 or 17 years. Cicadas spend most of their lives underground. There, immature forms called nymphs tap into the roots of trees and shrubs for sustenance—and possibly to eavesdrop on plant hormonal signals that betray the passage of seasons. When soil temperatures reach 64° F (about 18° C) in the year of emergence, the nymphs tunnel to the surface, climb the nearest tall object and molt into adults, living just two to four weeks and producing young that burrow into the soil to await a springtime more than a decade hence.

Raupp and others have found that the cicadas don't cause significant harm to the plants they parasitize. "It's a wonder that we don't see more damage," he says. But trees and shrubs do have a growth spurt the year after cicadas emerge (when feeding nymphs are especially small). That suggests root-slurping nymphs slow their hosts' growth.

As for why people are captivated by an insect that spends more than 99 percent of its life cycle out of sight, Raupp says, "perhaps it's the fascination of the abomination."

—*Sid Perkins*



Mapping cicadas

When colonists first encountered cicadas in America, the sudden swarms seemed a lot like plagues of locusts. Careful mapping later revealed that cicadas don't move across the landscape in waves as locusts do, instead emerging in certain places on 13-year or 17-year cycles. As this year's Brood II cicadas emerge, scientists are refining cicada maps, and you can help by reporting sightings at the Magicicada website, www.magicicada.org. Researchers will use the information to update maps of Brood II emergence in real time (sightings as of mid-May shown on map above). Analyzing the event will help scientists track the long-term health of forests and learn how cicadas might be responding to climate fluctuations. The first of this group appeared this year in North Carolina and Virginia. In New York's Hudson River Valley, people might see—and hear—cicadas as late as July.

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How to Outsmart a Millionaire

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

I wasn't looking for trouble. I sat in a café, sipping my espresso and enjoying the quiet. Then it got noisy. Mr. Bigshot rolled up in a roaring high-performance Italian sports car, dropping attitude like his $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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