

SCIENCE NEWS

THE WEEKLY NEWSMAGAZINE OF SCIENCE

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putting racism to the test
when black holes collide
glasses: an eye to the future
mediterranean food for thought

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leap of
time

SCIENCE NEWS

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This Week

Crash

Ripples of space-time debut in black hole simulations

When black holes collide, they cause surrounding space-time to wiggle, generating a torrent of radiation known as gravitational waves. That's what Einstein's general theory of relativity predicts, but computer models have struggled for more than 30 years to reproduce those waves. Because of the relativity theory's mathematical complexity and the extreme gravity of black holes, modelers hadn't succeeded in getting black holes to crash. Instead, the computer programs did.

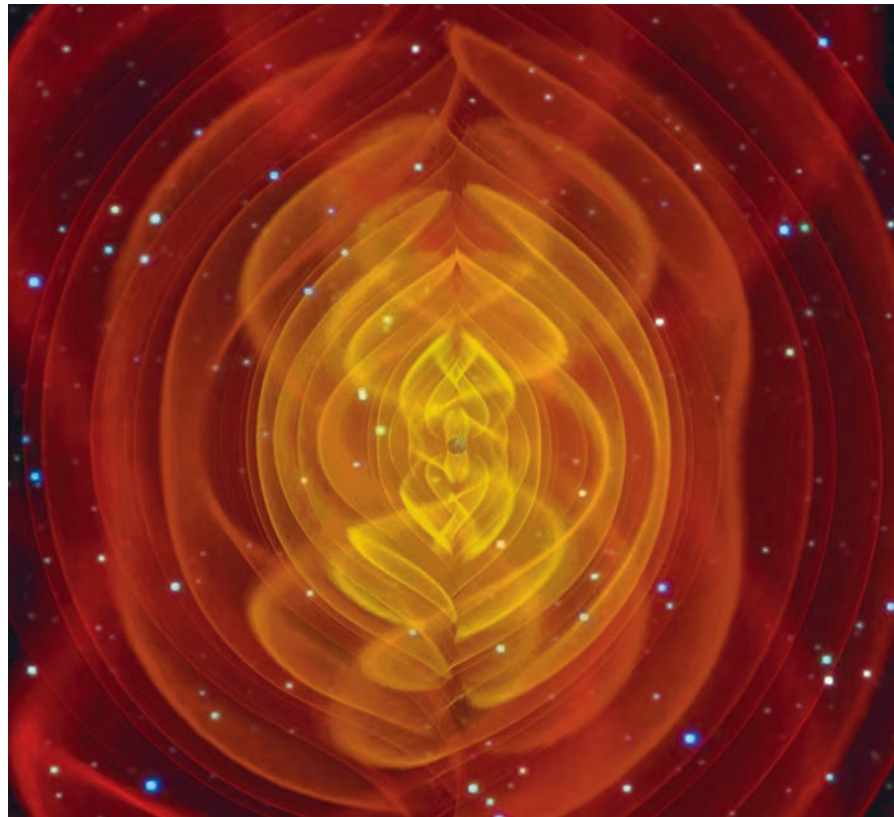
Now, two teams independently report that they have successfully simulated the merger of two black holes and the event's production of gravitational waves.

"This is a breakthrough not only in numerical relativity, but it is a necessary step in preparing us to observe gravity waves," comments theorist Stuart Shapiro of the University of Illinois at Urbana-Champaign. "It's also the first serious link between cosmology and the merger of black holes."

Observers have begun searches for gravitational waves using several ground-based networks (*SN: 1/8/00, p. 26*). A space-based detector is scheduled for launch early in the next decade. The waves described by the new simulations "are telling the detectors what to look for," says Carlos Lousto of the University of Texas at Brownsville.

Lousto and his colleagues, as well as a group led by John Baker and Joan Centrella of NASA's Goddard Space Flight Center in Greenbelt, Md., describe some of their work in the March 24 *Physical Review Letters*. Both groups also report new simulations in an upcoming *Physical Review D*.

Modelers had previously simulated gravitational waves produced by colliding neutron stars, which are city-size balls of neutrons. But colliding black holes presented more of a problem. The gravity of such a monstrous pair squeezes space-time to a point that has infinite density, the so-called singularity that a computer program has difficulty handling.



GRAVITY'S RIPPLES New computer simulations have modeled the gravitational radiation (yellow and orange waves) generated when two black holes merge (at center).

Some researchers, including the teams led by Baker and Lousto, deal with the singularity by isolating it "into a corner of the computer grid never seen by the computer code," explains Shapiro. "Most people who might have thought about this method were afraid to try it," he says. That strategy seemed destined to fail, says Shapiro, because people thought, "you can run [from a singularity], but you can't hide."

Nevertheless, the simple approach enabled the modelers to watch the gravitational waves emitted by two orbiting, equal-mass black holes in the critical period hours or seconds before they coalesced.

Newer work by the Goddard team focuses on black hole collisions in which one of the bodies is heavier than the other. In such unequal-mass collisions, gravitational waves are concentrated in a specific direction, propelling the merged body in the opposite direction.

Such kicks might have played a crucial role in the growth of supermassive black holes when the universe was about half a billion years old. The center of nearly every new galaxy back then probably housed a fledgling black hole. Collisions between two unequal-size black holes could have generated a gravitational-wave kick big enough to eject each member of the pair from its home galaxy, making unlikely any further growth of those black holes or their galaxies.

The strength of the kick revealed by the Goddard simulation suggests that gravita-

tional waves could indeed have controlled the growth of black holes and galaxies.

The findings shed light "on a huge cosmological problem of how ... supermassive black holes in galaxies grow into bigger ones," says Shapiro. —R. COWEN

Switch-a-Vision

Electric spectacles could aid aging eyes

A new type of eyeglasses with electrically adjustable focus might someday render bifocals and reading glasses obsolete, the device's inventors say. So far, the researchers have made a battery-powered prototype with close-up focus that flicks on and off with a switch.

Future versions of the eyeglasses may incorporate a distance sensor to automatically adjust the focus as the viewer's gaze changes between far and near viewing, says one of the inventors, electrical engineer David L. Mathine of the University of Arizona in Tucson.

Most people by their late 40s can no longer focus on close objects. This visual defect is known as presbyopia. The company PixelOptics of Roanoke, Va., plans to create a commercial version of the electrically adjusted eyeglasses to market to presbyopic people, who typically wear bifocals,

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trifocals, or graded lenses. Worldwide, about 50 million people per year become presbyopic, according to the company's Web site.

In bifocals, some portion of the lens remains unfocused for the distance of interest at any given time, notes Mathine. In the new eyeglasses, the entire lens switches to the desired focus. For close vision, for instance, "you don't have just the bottom half of your eyeglasses. You get the whole view," he says.

To make eyeglass lenses that change focus electrically, the researchers created sandwiches of glass sheets separated by a fluid layer 5 micrometers thick. The filling consists of a transparent substance, a type of liquid crystal, that's made up of rod-shaped molecules suspended in a liquid (*SN*: 12/20⁰³27/03, p. 388). The team used precise computer-chip-manufacturing methods to apply a bull's-eye pattern of transparent electrodes to the inner surface of one of the glass sheets.

In response to voltages applied to those electrodes, the liquid-crystal rods rotate into new orientations, explains Guoqiang Li of the University of Arizona and a member of the development team. The rod orientation determines the speed at which light passes through the liquid-crystal layer. Light rays bend as they traverse the layer and so can become focused, much as they would when passing through an ordinary lens.

The researchers describe the new eyeglasses in the April 18 *Proceedings of the National Academy of Sciences*.

In the past, other scientists have made electrically controlled lenses from liquid crystals—using them, for instance, to steer laser beams or to alter the focus of a reader used in optical-memory devices. However, previ-

ous liquid-crystal lenses could neither focus well enough nor change their focus quickly enough for use in eyeglasses, Li says.

The newly developed lens is "the only adaptive lens that is practical for presbyopia patients," says biomedical and optical engineer Shuliang Jiao of the University of Miami (Fla.) School of Medicine, who didn't participate in the research.

PixelOptics plans to create a version of the glasses that will enable people to have better than normal 20/20 vision, says physicist Dwight P. Duston, head of research and development for the company. —P. WEISS

Decent Interval

Well-spaced babies may have advantage

Babies conceived 18 months to 5 years after a previous birth are healthier than those conceived at shorter or longer intervals, a massive data analysis shows.

Studies to determine the optimal spacing between a birth and the mother's next pregnancy have yielded mixed results. In an attempt to settle the question, researchers in Colombia analyzed 67 studies that included more than 11 million births worldwide.

Compared with babies conceived 18 to 23 months after a sibling's birth, those conceived within 6 months were 40 percent more likely to be born prematurely, 61 percent more likely to be underweight (less than 2.5 kilograms, or 5.5 pounds), and 26 percent more likely to be small for their gestational age at birth. Babies conceived between 6 and 17 months after their mothers' previous birth also had a slightly increased risk of the three health measures, whereas babies conceived 24 to 59 months after a previous birth had no increased risk.

Premature birth, low birthweight, and small size for gestational age are all risk factors for poor health in infancy and can lead to complications later in life.

Health officials should counsel women who've just given birth to delay their next conception by 18 to 59 months, concludes study leader Augustin Conde-Agudelo of the Santa Fe Foundation in Bogotá.

"This is the first, and certainly the most ambitious, attempt to do this sort of rigorous meta-analysis" of the birth interval, says physician C. Johannes van Dam of the Population Council in New York City.

Curiously, babies conceived 5 years or more after a birth were 20, 29, and 43 percent more likely to be premature, small for gestational age, or underweight, respectively, than were the babies conceived after 18 to 23 months, the researchers report in the April 19 *Journal of the American Medical Association*.

It's unclear why a long interval would impart such risks.

The problems of a baby born after a short interval are better understood. The second baby might suffer because the mother is nutritionally depleted and physically stressed by simultaneously recovering from the first birth, handling an infant, and carrying a new fetus, van Dam says.

Epidemiologist Mark A. Klebanoff of the National Institute of Child Health and Human Development in Bethesda, Md., questions whether getting pregnant soon after a birth is the primary factor that places a pregnancy at high risk. "Is there something about women who get pregnant right away that imparts the risk?" he asks.

He cites earlier research showing that women with very long or short birth intervals are more likely to be unmarried and have less education than other women. Although Conde-Agudelo's team tried to account for these and other differences, many of the studies in their analysis relied on birth certificates, which, Klebanoff says, "are notoriously incomplete and inaccurate."

Worldwide, roughly half of all births are unplanned. Doctors should counsel new mothers against having another child right away, van Dam says. The best results will come in countries with birth control programs and prevalent breast-feeding, which naturally delays a woman's return to fertility. —N. SEPPA

Me and My Metabolism

Personalized medicine takes new direction

Physicians may someday predict a drug's toxic effects in individual patients on the basis of their metabolisms, a proof-of-principle study in rats suggests. The finding could lead to a major shift in expectations for personalized medicine, which

LI ET AL./PNAS



LOOK OUT Electric signals from microchips in the black boxes attached to these prototype eyeglasses change focus settings to improve near vision.

scientists generally have presumed would center on genetics.

Since people can vary widely in how they react to a particular medication type or dosage, many doctors consider personalized treatment to be one of medicine's loftiest goals. Efforts to reach this end have focused mostly on pharmacogenomics, the study of how a person's unique pattern of genes affects how he or she responds to any given drug.

However, notes biochemist Jeremy K. Nicholson of Imperial College London, genes can tell only so much about a body's functions. Other factors, such as age, weight, emotional state, and gut bacteria, can have an enormous influence on how a patient processes medications. "Things that affect our lives quite a lot aren't reflected in our genomes," says Nicholson.

Since these factors influence metabolism, he and his colleagues wondered whether they could use individuals' metabolic profiles before they receive medication to predict how patients might react to drugs. The scientists have named this approach pharmaco-metabonomics.

To test their idea, Nicholson's team worked with 75 rats that belonged to an inbred strain and thus had closely matching genomes. The scientists began their work by collecting urine from all the animals. The researchers then ran all the samples through a machine that measured hundreds of molecules. The results provided a metabolic signature that varied slightly from rat to rat.

Next, the researchers fed each animal acetaminophen (Tylenol) in a single dose known to cause liver damage without killing a rat. Liver damage varied from animal to animal, despite the rats' genetic similarities.

In half the rats, Nicholson and his colleagues examined whether the metabolic signatures correlated with the extent of the animals' liver damage. Sure enough, the researchers found a striking relationship between the rats' unique patterns of urine molecules and the toxic effects of the drug. Using this information, the scientists predicted with about 85 percent accuracy the liver damage in a second group of animals. Nicholson's team reports these results in the April 20 *Nature*.

"This could be a very important advance in the study of personalized medicine," says Richard Cote, a cancer researcher at the University of Southern California in Los Angeles. He adds that this approach eventually may give physicians a sense of a drug's efficacy, as well as its toxicity, in an individual. Such information could prevent them from wasting time and money on ineffective treatments.

However, says David Jones of the Massachusetts Institute of Technology, researchers shouldn't hastily give up on pharmacogenomics. Day-to-day variations in a

patient's routine could necessitate constant metabolic testing to make sure treatments are on target. On the other hand, he adds, "with pharmacogenomics, the answer you get is good for life." —C. BROWNLEE

Dementia off the Menu

Mediterranean diet tied to low Alzheimer's risk

People who eat a Mediterranean-style diet are less likely than their peers to develop Alzheimer's disease, according to new research on elderly Manhattan residents. The study is the first to link brain benefits to a comprehensive dietary pattern rather than to individual foods or nutrients, say the scientists who performed the research.

Traditional Mediterranean menus are rich in fruits and vegetables, fish, and unsat-



BRAIN FOODS A diet rich in vegetables, their oils, and certain other menu choices appears to guard against Alzheimer's.

urated fat. They contain little saturated fat from meat or whole-fat dairy products. Meals often feature moderate alcohol consumption.

"This overall dietary pattern is associated with decreased risk of a series of diseases," says neurologist Nikolaos Scarmeas of Columbia University Medical Center. Those diseases include cardiovascular disorders, diabetes, and certain cancers.

Some studies that have focused on a single component of the diet—frequent fish consumption, for example—have found evidence of neurological benefits. But others

have not, perhaps because the elements of the diet don't have much effect unless they're combined, Scarmeas says.

To gather information on people's diets and cognitive status, Columbia researchers went door to door in a largely Hispanic and African American neighborhood near the university. In all, the researchers signed up 2,258 New Yorkers who were at least 65 years old and did not initially have dementia. The volunteers' average age was 77.

The researchers graded each volunteer's diet as either a 0 or a 1 on nine specific measures. A volunteer got a point, for instance, by routinely eating more legumes than did most other volunteers; he or she got other points by consuming less meat or less dairy.

The researchers periodically reevaluated each volunteer's cognitive state. They found that 262 participants developed Alzheimer's disease during an average of 4 years.

People whose diets initially resembled the Mediterranean diet most closely—those with a diet score of 6 or above—had about a 40 percent reduced risk of developing Alzheimer's during the study compared with people who scored 3 or below. Volunteers who had moderately Mediterranean-like diets, reflected by a score of 4 or 5 out of 9, faced an intermediate risk of Alzheimer's, Scarmeas' team reports in an upcoming *Annals of Neurology*.

The diet-scoring system used in the study "is far from perfect," comments Irwin Rosenberg, director of the Nutrition and Neurocognition Laboratory at Tufts University's Human Nutrition Research Center in Boston. "But it's at least a step in the direction of trying to judge [Alzheimer's risk] from dietary patterns rather than simple nutrient associations."

While the researchers labeled the healthiest pattern as a Mediterranean diet, "it's not a Mediterranean diet," comments epidemiologist Martha Clare Morris of Rush University Medical Center in Chicago. By Mediterranean standards, even high-scoring volunteers consumed relatively little olive oil and other healthy oils.

Nevertheless, Morris and others say that the finding supports the contention that a diet heavy in fruits, vegetables, and fish, along with moderate alcohol intake, may protect the brain. —B. HARDER

Picking Pathways

Small molecule boosts morphine effect

Some small molecules affect specific pathways in one of the body's most common cell-regulating systems, according to a new report. The work could aid investigations of

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the pathways and lead to new drug therapies, the report's authors say.

When certain cell-surface receptors bind a chemical stimulus, such as an opiate or a hormone, they interact with so-called G proteins. These three-subunit proteins then separate into two parts, known as alpha and beta-gamma. Alan V. Smrcka of the University of Rochester in New York and his colleagues focused on the beta-gamma part.

That double subunit binds to and activates many enzymes that carry out a cellular response, such as mediating pain relief, explains Smrcka.

In past work, Smrcka and his colleagues investigated how beta-gamma can recognize such a diverse group of enzymes. Smrcka's team and other researchers found that the beta surface has a hot spot, an area that offers binding opportunities to many different target enzymes. Hydrophobic interactions bind some proteins there, while hydrogen bonding or other forces attach yet other proteins to the hot spot.

In the current study, the team showed that manipulating the hot spot "selectively interferes with what beta-gamma does," says Smrcka.

The researchers screened nearly 2,000 compounds from a library of small organic molecules, identifying 85 that had a high affinity for the hot spot. The team reports on two of those compounds that affect beta-gamma in cultured cells.

"Both compounds are binding to the hot spot, but they interrupt different sets of interactions," says Smrcka. For example, one of the compounds, called M119, blocked the subunit's interaction with an enzyme called phospholipase C, but the other compound didn't. Yet both compounds blocked the subunit's binding to an enzyme called G-protein-coupled receptor kinase.

Because M119 blocked phospholipase C and previous studies had suggested that phospholipase C blunts morphine's pain relief, the researchers tested M119's effect on the morphine-triggered pathway. Smrcka's team reports in the April 21 *Science* that morphine administered with M119 to mice is 11 times as potent as morphine alone is.

If M119 had shut off the beta-gamma subunits' action, says Smrcka, it would have blocked morphine's pain relief. Instead, the compound intensified pain relief by stopping the activity of phospholipase C while "leaving the rest of what beta-gamma is doing intact," he says.

"It's a very interesting mode of action for

a small molecule to bind to one protein and augment its ability to act with another," says pharmacologist Elliott Ross of the University of Texas Southwestern Medical Center in Dallas.

Smrcka's team is now further investigating the morphine-enhancing compound. While the specific compounds that the team has so far identified may not become drugs, the study indicates the potential for small molecules to modify the many existing drugs that work by influencing G-protein-coupled receptors, Smrcka says. —A. CUNNINGHAM

Babies Prune Their Focus

Perception narrows toward infancy's end

Rather than crawling inexorably toward a better appreciation of the world around them, infants take a perceptual step backward before their first birthday, a new study indicates. That reversal, ironically, paves the way for advances in thinking later in childhood.

When shown videotapes of monkeys' faces that either matched or clashed with sounds being made by the animals, 4- and 6-month-olds preferred to look at matches, whereas 8- and 10-month-olds displayed no preference, say David J. Lewkowicz of Florida Atlantic University in Boca Raton and Asif A. Ghazanfar of Princeton University. Looking preferences in the younger babies denoted an awareness of associations between faces and vocalizations, the researchers assert.

Younger infants probably noted when facial movements were synchronized with vocalizations, the two psychologists assert in the April 25 *Proceedings of the National Academy of Sciences*. The older infants ignored the basic phenomenon of synchrony because they had entered a phase of looking for more-complex features of human faces and voices, the scientists propose.

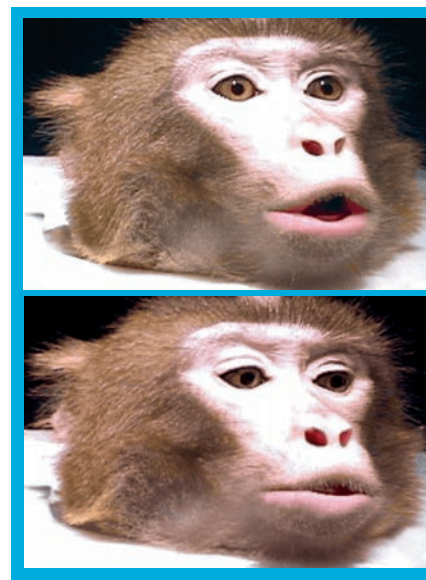
"We're tapping into a transition period in late infancy when ... it's more difficult to perceive links between different sensations," Lewkowicz says. Constrictive phases characterize development of various types of perception, in his view.

For instance, other researchers have found that, between 6 and 10 months of age, infants improve at discriminating among sounds in their native languages and among different people's faces. During that same time, youngsters become worse at telling apart foreign-language sounds and other species' faces, such as those of monkeys (*SN*: 5/18/02, p. 307).

Lewkowicz and Ghazanfar suspected

that a comparable form of perceptual narrowing occurs as babies learn about critical relationships between different sensations, such as sights and sounds. The experiment consisted of 33 infants at 4 months of age, 57 at 6 months, 54 at 8 months, and 32 at 10 months.

Each baby sat in front of two adjacent video monitors and completed four 1-minute trials. Flashing lights drew each infant's attention to the monitors as pairs of videos showed monkeys' faces making either coo or grunt calls. Characteristic lip and facial movements for each call were accompanied either by the sound of the same call or by the sound of the other call.



CALL ME Younger human infants, but not older ones, preferred looking at videos in which calls made by monkeys matched facial movements for coos (top) and grunts (bottom).

At the two youngest ages, infants looked substantially longer at faces that made matching calls than they did at faces that emitted mismatched calls. At the two oldest ages, infants looked at instances of matched and mismatched calls for about the same amount of time.

It's already known that, after 3 months of age, babies associate people's faces with their vocalizations, Lewkowicz notes. As perceptual experience in this vital social realm mounts during infancy, youngsters temporarily lose the broader capacity to recognize links between the facial movements and vocalizations of other species, he proposes.

Olivier Pascalis, a psychologist at the University of Sheffield in England, agrees. "There are clearly a series of transitions going on that move babies from a broad perceptual system toward a specialized one," he says.

Lewkowicz plans to examine at what age, after 10 months, sensory-matching ability reappears. —B. BOWER

LEWKOWICZ

Money, Morals, Immortality— What Do We Value?

Decide for yourself with a fascinating professor's
24 lectures about choices, chances, rules, and free will

Our lives are filled with everyday questions of fact and finance. Which investment brings the highest return? What school district is the house in? What will this candidate actually do if elected? But the really fundamental questions of our lives, says Professor Patrick Grim, are questions of neither fact nor finance. The really fundamental questions are questions of value. These are the deep questions that apply to every aspect of our lives.

What is it that gives something genuine value? What things are really worth striving for? What is it that makes life worth living? Are there values that transcend cultural differences? Can we have ethical values without religion? If the universe operates in terms of deterministic laws, how can there be real choice? Is all value subjective? We can even ask if life is always worth living, or whether in some situations we would be better off dead.

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What values, for instance, are involved in thinking about life and death? What values are evident in a yearning for immortality? The lines of discussion raised throughout the course are regularly as provocative as these, and Professor Grim means them to be exactly that.

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Justice is a concept involving the fair, moral, and impartial treatment of all persons, especially in law.

About Your Professor

Dr. Patrick Grim is a Distinguished Teaching Professor of Philosophy at the State University of New York at Stony Brook. While a Fulbright Fellow at the University of St. Andrews, Scotland, he earned his B.Phil. He received his Ph.D. from Boston University. He is the author of *The Incomplete Universe: Totality, Knowledge, and Truth* and the founding coeditor of more than 20 volumes of *The Philosopher's Annual*. He has been awarded the President and Chancellor's awards for excellence in teaching and has been elected to the Academy of Teachers and Scholars.

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TO LEAP OR NOT TO LEAP

Scientists debate a timely issue

BY RON COWEN

Did last New Year's Eve seem a trifle tedious? Did your celebration go on a little too long? Maybe that's because just before midnight Greenwich Mean Time—6:59:59 Eastern Standard Time to be exact—the international authority on timekeeping ordered everyone to wait a second. For the 23rd time since 1972, the International Earth Rotation and Reference System Service added an extra second to the time standard, a worldwide network of some 200 atomic clocks.

The clocks, most of them governed by the ultrasteady vibrations of electrons in cesium atoms, are accurate to a tenth of a billionth of a second a day. However, humankind's oldest clock—Earth's rotation—isn't nearly so precise. Primarily in response to the moon's tidal pull on the oceans, our planet isn't turning quite as fast as it used to. To keep Earth time and atomic time in sync, experts have agreed to insert a leap second every few years into the official atomic-based standard, which is called Coordinated Universal Time.

Because the rate at which Earth slows isn't perfectly predictable from year to year, leap seconds are announced only 6 months in advance. That's a concern for software designers, operators of satellite-based systems, and anyone else who relies on split-second communications. Six months isn't much warning for engineers who operate computer programs or types of equipment that require precise time information and are intended to last for at least a decade. Some operations, such as the Global Positioning System, use custom time scales that eschew leap seconds entirely.

A glitch in inserting a leap second, these researchers say, could throw everything off, whether it's the timing of an international business deal, the location that a missile hits, or the star that the Hubble Space Telescope observes. "A 1-second hiccup in the phasing of North American power grids would likely cause a hemispheric blackout," notes Daniel Kleppner, director of the Massachusetts Institute of Technology-Harvard Center for Ultracold Atoms in Cambridge, Mass., in the March *Physics Today*.

Inserting a leap second "is a little bit like walking along the San Andreas fault," comments Tom Van Baak, a self-described precision-time hobbyist from Bellevue, Wash. It's typically an innocuous experience, but there's always the potential for catastrophe lurking beneath the surface.

With Earth continuing to grow more sluggish, scientists note, leap seconds will have to be introduced more and more frequently. "Eventually, you get to the point that the paradigm involved in this won't work," says Dennis McCarthy, a time specialist now retired from the U.S. Naval Observatory. "You've got to do something different. The addition of leap seconds is going to be an increasing nuisance for people who are counting on a time scale where a minute actually contains 60 seconds."

That's why a group of U.S. time-communication specialists, part of the International Telecommunications Union, proposed in 2004 to do away with leap seconds altogether. Let atomic time be out of whack with Earth rotation-based time, these scientists say. Their proposal is now under review by a working group of the union.

But to many astronomers, doing away with the leap second is anathema. It would be a major headache for hundreds of observatories to keep track of the heavens using a time measure that no longer had anything to do with the Earth's rotation, says astronomer Steve Allen of the University of California, Santa Cruz.

Then, there's the philosophical objection. For thousands of years, he notes, a clock was set by where the sun was in the sky. It was morning when the sun rose, noon when it was directly overhead. If your clock didn't agree with that phenomenon, you reset it.

If leap seconds were abandoned, noon atomic time might eventually correspond to sunset on Earth. It all boils down to "what should a clock tell you and what it [traditionally] has told you," Allen notes.

So, whose time is it anyway?



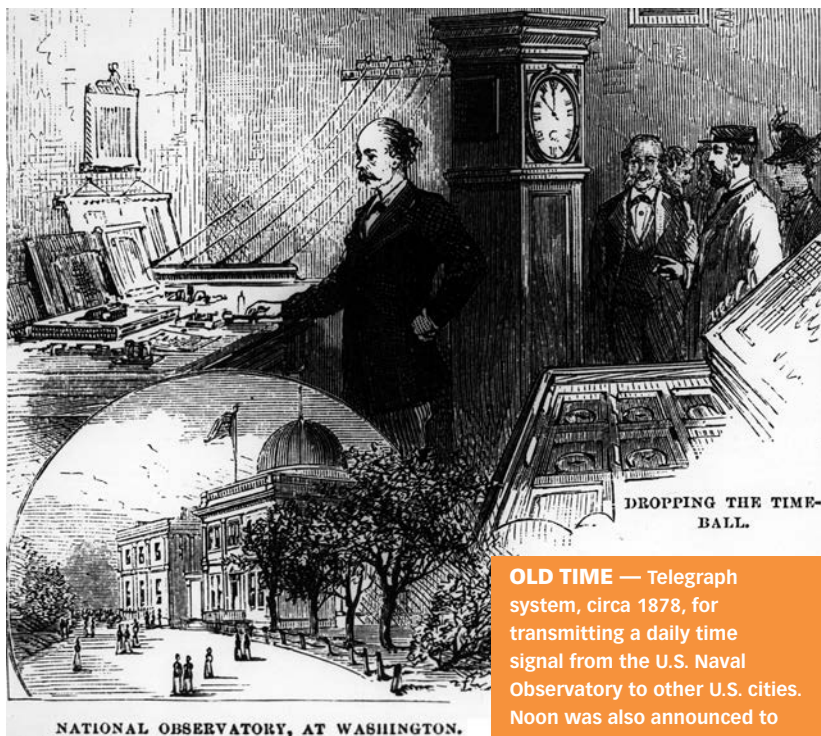
TICK-TOCK — The master clock system at the U.S. Naval Observatory in Washington, D.C., relies on a comparison of several dozen atomic clocks.

SLUGGISH EARTH A variety of competing effects, including the moon's tug on the oceans and the melting of glaciers, combines to slow Earth's spin. A day now is about 0.002 second shorter than it was a century ago. Some 150 million years ago, dinosaurs had to jam a full day of foraging and killing into what is now only 22 hours.

Observations of solar eclipses and comets recorded over the past 4,000 years provide graphic evidence of the slowdown. Tracing these events back in time, modern astronomers can account for the locations of eyewitnesses only if Earth had been rotating faster in the past than it does today, McCarthy notes.

Although scientists more than a century ago discerned Earth's sluggishness, the rotation of the planet remained the unbeatable standard against which all mechanical clocks, from the pendulum to the marine chronometer, were set. The second was defined in terms of Earth's rotation in 1900, as 1/86,400 the length of the average day, as indicated by when the sun set.

G. CHESTER/USNO



NATIONAL OBSERVATORY, AT WASHINGTON.

OLD TIME — Telegraph system, circa 1878, for transmitting a daily time signal from the U.S. Naval Observatory to other U.S. cities. Noon was also announced to Washingtonians by the drop of a ball from the observatory's telescope dome (inset).

In 1949, physicists developed the first type of atomic clock. Still one of the standards, this clock is based upon a transition between two closely spaced energy levels in cesium atoms. The transition occurs at a frequency of 9,192,631,770 cycles per second. That frequency is accurate to 2 nanoseconds per day, so it provides a fundamental measure of time.

Another type of atomic clock, based on the coherent excitation of large numbers of hydrogen atoms, is even stabler than the cesium clock on time scales of about a week, though less stable on longer times.

Both types of atomic clocks are used to determine the international standard. It relies on comparisons among clocks at 55 locations worldwide, including about 100 clocks located at the U.S. Naval Observatory in Washington, D.C., and at its facility at the Schriever Air Force Base in Colorado Springs, Colo.

The biggest challenge in keeping Earth time and atomic time in harmony is that Earth doesn't decelerate steadily. While the friction generated by the sloshing back and forth of tides dominates the braking action, other, smaller effects work in the opposite direction.

One confounding factor, notes McCarthy, is the melting of glaciers since Earth's last ice age. Under gravity's influence, the water from melting ice flows away from high-altitude regions and packs additional mass onto lower-lying regions. The flow of material from high to low elevations causes a tiny increase in Earth's rotational speed. Uncertainties in predicting ice melts add to the difficulty in predicting the planet's spin.

THE CORRECTION To determine exactly how Earth's rotation varies from week to week and month to month, NASA and the Naval Observatory use a network of radio telescopes to precisely locate some 600 quasars, the brilliant beacons at the centers of distant galaxies. Because Earth is slowing down, the positions of the quasars appear to shift ever so slightly over time. The telescopes can discern the shift over a period of weeks.

Using these data, the International Earth Rotation and Reference System Service determines when the slow-down is large enough to warrant the introduction of another leap second. The service won't decide until June whether timekeepers will need to insert a leap second at the end of 2006.

It's the unpredictability of leap seconds that creates the poten-

tial for problems, says McCarthy. People "want to be assured that there's a uniform time that they can make use of," he says.

One of the issues facing timekeepers is that there's no standard way to insert a leap second. Although the extra second is usually inserted as the 61st second of a minute, some software and some digital clocks don't implement the leap second in that way, notes McCarthy. Some clocks either go blank for a second, read the 60th second twice, or stay at zero for 2 seconds. Differences in adding the leap second increase the likelihood of errors or confusion.

"If I were a communications company and wanted to make sure I never got bothered [with a leap second], I'd create my own sort of internal time scale," McCarthy says. "Then there's a concern that if everyone started doing this, there'd be a [complete] lack of standardization."

Banks, armies, or any group of institutions depending on close coordination could start acting "like a dysfunctional family," says Allen.

FUTURE TIME McCarthy and other scientists propose a compromise in the leap-second debate: Continue to make corrections but at longer intervals. The challenge would be to balance the inconvenience of the two types of times drifting apart with the chance that the adjustment would introduce glitches in time-sensitive communications.

One suggestion is to insert a bundle of leap seconds in official worldwide time only once every decade and to give everyone at least several years' advance warning of the total. If it turns out that the guesstimate of Earth's rotation-time change were wrong, an adjustment could be made in the next go-round.

Another possibility would be to avoid any change in standard atomic time until the disparity between the clocks and Earth's rotation becomes, say, an entire hour. That wouldn't happen for another 400 years.

In the meantime, a new problem looms. The inextricable link between gravity and time becomes increasingly apparent as atomic clocks become more and more precise. Every decade since the mid-1950s, the accuracy of atomic clocks has improved tenfold, notes Kleppner. The clocks are approaching an accuracy of 1 part in 10^{16} , and newer systems, based on the vibrations of laser-cooled atoms and ions, are expected to eventually attain 1 part in 10^{18} .

Einstein's general theory of relativity predicts, and atomic clocks have confirmed, that clocks at higher elevations run slightly faster than do those closer to the ground. Given the current accuracy of clocks, this gravitational effect requires that researchers know the altitude of timekeeping laboratories to within a few meters. Ultimately, altitudes would have to be measured to within a centimeter.

That becomes tricky because gravitational theory dictates that the altitude isn't measured relative to average sea level, but to the geoid, a hypothetical surface that approximates the shape and size of Earth. The geoid's size fluctuates in response to, for example, ocean tides and the redistribution of water due to climate changes.

These "shakes and shimmies" would make comparisons of future, ultraprecise atomic clocks kept at different locations "no more meaningful than comparing the rates of pendulum clocks on small ships scattered in the oceans, each bobbing in its own way and keeping its own time," says Kleppner.

An alternative would be for nations to agree to define the second on the basis of clocks at just one terrestrial location. But the politics involved in such a decision could make this unrealistic, Kleppner adds.

"We may be making clocks that are more precise than time itself can be defined on Earth," says Kleppner. The timekeeping of such clocks, he concludes, would be too good to be true. ■

THE BIAS FINDERS

A test of unconscious attitudes polarizes psychologists

BY BRUCE BOWER

It lurks in the mind's dark basement, secretly shaping our opinions, attitudes, and stereotypes. This devious manipulator does its best to twist our behavior to its nefarious end. Its stock in trade: stirring up racial prejudice and a host of other pernicious preconceptions about members of various groups. Upstairs, our conscious mind ignores this pushy cellar dweller and assumes that we're decent folk whose actions usually reflect good intentions.

Welcome to the disturbing world of implicit bias, where people's preferences for racial, ethnic, and other groups lie outside their awareness and often clash with their professed beliefs about those groups. In the past 15 years, most social psychologists have come to agree that implicit biases, also known as unconscious attitudes, play an often-unnoticed role in our lives. Researchers study implicit biases using any of several techniques, such as tracking participants' feelings and behaviors after subliminally showing them pictures of black or old people.

However, one measure—the Implicit Association Test, or IAT—has proved especially popular. Since its introduction in 1998, more than 250 IAT-related studies have been published. More than 3 million IATs have been completed on a Web site (<https://implicit.harvard.edu/implicit/>) established by the test's major proponents—Anthony G. Greenwald of the University of Washington in Seattle, Mahzarin R. Banaji of Harvard University, and Brian A. Nosek of the University of Virginia in Charlottesville. Other online venues run by organizations concerned about various types of discrimination also offer the IAT to visitors.

The huge IAT database contains troubling findings that have been highly publicized. For example, more than three-quarters of white and Asian test takers in the United States display an unconscious tendency to value white people over black people. Roughly half of black test takers show a pro-white bias as well. Many people who complete the IAT exhibit implicit inclinations for young versus old people and unconsciously favor men over women.

Such results challenge the traditional view in psychology that each person knows his or her social attitudes and stereotypes, Banaji says. People maintain unconscious preferences for certain social groups over others, even if they disavow those preferences when asked about them, in her view. In the post-Civil Rights era, few people admit to harboring ill will toward blacks or to acting in a racially discriminating style, but IAT results reveal a stubborn undercurrent of white favoritism with the potential to stoke bigoted behavior, in Banaji's view.

Virtually from the start, the test sparked a schism in social psychology. The IAT taps into much more than individuals' unconscious attitudes, critics contend. Familiarity with members of those groups, knowledge of cultural attitudes toward particular groups, and test-taking tactics influence IAT scores, they say.

Critics also argue that specific IAT scores are meaningless because they haven't been tied to relevant, real-world behaviors. No one should assume that he or she is unconsciously prejudiced against black people on the basis of an IAT score, these investigators hold.

Psychologist William von Hippel of the University of New South Wales in Sydney, Australia, has followed the IAT debate closely. "Rarely has a methodological tool garnered such strong adherents and detractors," von Hippel says. "The IAT should be vigorously researched and debated, but we still do not really understand what it reveals."

FEEL THE CONFLICT Go to the IAT Web site and you can probe personal preferences on more than 90 topics, including pets, politics, sports teams, and musical styles. But the IAT measure of attitudes about race draws the most attention. The roughly 5-minute, two-part test "provides a palpable experience of mental conflict that leads to an opportunity for self-examination," says Nosek.

The IAT measures the ease with which people associate words or pictures representing either of two contrasting groups—such as white people and black people or men and women—with positive or negative meanings.

For instance, on one popular version of the racial IAT, participants first press a certain key on a computer keyboard as quickly as possible when they see either an image of a black person's face or a word, such as *tragedy* or *rotten*, that has unpleasant connotations. They press another key when they see either an image of a white person's face or a word, such as *love* or *health*, that has pleasant implications.

In a reversal of this task, participants then rapidly press the same key in response to either black faces or pleasant words and another key when shown either white faces or unpleasant words.

Many volunteers, as they take the test, realize that it's easier to link black faces with unpleasant words and white faces with pleasant words than vice versa. Greenwald and his coworkers surmised in 1998 that the speedier such associations occurred, the more participants unconsciously preferred whites to blacks.

Several investigations suggest that it's difficult to initially manipulate one's IAT score. However, people who take the IAT many times or who receive explicit cheating instructions can fake their scores. "I've taken the IAT so many times that I know how to get any score I want to on it," Nosek says.

Still, the IAT does a good job of tapping into the implicit attitudes that it's supposed to measure, he asserts.

In particular, Nosek cites Yale University psychologist T. Andrew Poehlman's unpublished statistical review of 61 studies. It finds that IAT scores do better than self-reports at forecasting results of lab tests of behavior motivated by stereotypes and racial attitudes. For

"Rarely has a methodological tool garnered such strong adherents and detractors."

— WILLIAM VON HIPPEL,
UNIVERSITY OF
NEW SOUTH WALES

instance, white people who describe themselves as unaffected by a person's race but display strong implicit bias against blacks on the IAT are especially apt to make unfriendly or rude overtures toward a black person in a brief laboratory encounter.

In contrast, in predicting choices of consumer products and political candidates, self-reports prove superior to IAT scores, according to Poehlman's review.

In another unpublished study, not included in the review, Banaji and her coworkers found that, among 291 white physicians, those exhibiting strong implicit bias against blacks also prescribed a state-of-the-art heart treatment far more often to hypothetical white patients than to their black counterparts.

IMPLICITLY YOURS According to its proponents, the IAT illuminates a common characteristic of unconscious attitudes toward ethnic and social groups: Such views are easily formed but hard to change.

The 46 college students participating in psychologist Aiden P. Gregg's experiment had never heard of Niffites or Luupites, but they were asked to imagine the two make-believe ethnic groups. In the experiment at the University of Southampton in England, each participant read an account of how one group, depicted as savage and ruthless, invaded and slaughtered the other, portrayed as civilized and peaceful.

The participants then read a series of names on a computer screen. Niffite names featured a double consonant and ended in "nif," such as Eskannif. Luupite names included a double vowel and ended in "lup," such as Neenolup. Each name from the designated invading group was preceded by a subliminally presented negative word, such as *barbaric*. Each name from the victim group was preceded by a subliminally presented positive word, such as *benevolent*.

Immediately afterward, students reported not only a conscious preference for the peaceful group but also displayed an implicit preference for it over the invading group on an IAT.

In further experiments at universities in Germany and the United States, students were told about Niffites and Luupites as in previous tests. They then either were informed that a computer error had accidentally switched descriptions of the imaginary groups or were given a new passage to read that described how historical forces had turned the victims into vengeful aggressors, while the original invaders became peaceful.

Self-reported opinions about the groups usually reversed at that point, says Gregg. In contrast, original implicit attitudes toward the groups remained largely the same, Gregg's team reports in the *January Journal of Personality and Social Psychology*.

"If automatic attitudes prove to be generally easier to acquire than they are to eliminate ... then right-minded attitudes should be instilled first before wrong-headed ones gain a foothold," the researchers conclude.

MYSTERY METRIC No one knows how, or whether, IAT scores apply to relevant real-life behaviors, says psychologist Hart Blanton of Texas A&M University in College Station. For instance, researchers who rely on the test consider a racial IAT score of 1.3 an indication of a strong unconscious bias against blacks. But it's unclear whether a person who scores 1.3 is more likely to, say, hire whites over blacks than is a person who scores 1.2 or 0.6.

Although IAT scores forecast volunteers' behavior in laboratory situations better than self-reports do, Poehlman's review shows that the test's capacity to predict behaviors related to racial prejudice or other malign attitudes is still relatively weak, Blanton says.

The test operates on vague and questionable theoretical assumptions about attitude formation, Blanton contends. Several serious problems mar interpretations of the results.

It's not known whether the range of possible scores on the racial IAT encompasses the entire range of implicit preferences toward whites and blacks, Blanton and James Jaccard of Florida International University in Miami assert in the January *American Psychologist*. The IAT may cover only the low-to-middle end of the actual range, or only the middle-to-upper end of the range. Many psychological measures, including popular self-esteem and depression scales, have the same limitation.

Consider the racial-association test, which contrasts the relative speed of making positive and negative associations to blacks and whites. A person whose score indicates implicit antiblack bias may regard blacks negatively and whites positively, may regard both groups positively but whites more so, or may regard both groups negatively but blacks more so. A final score offers no help in distinguishing among these possibilities.

Moreover, implicit bias may stem primarily from attitudes toward a single racial group, not from a preference for one group over another, Blanton suggests. Racist views held by volunteers primarily reflect an implicit tendency to view blacks negatively, regardless of the volunteers' opinion about whites, he and his coworkers propose in the March *Journal of Experimental Social Psychology*.

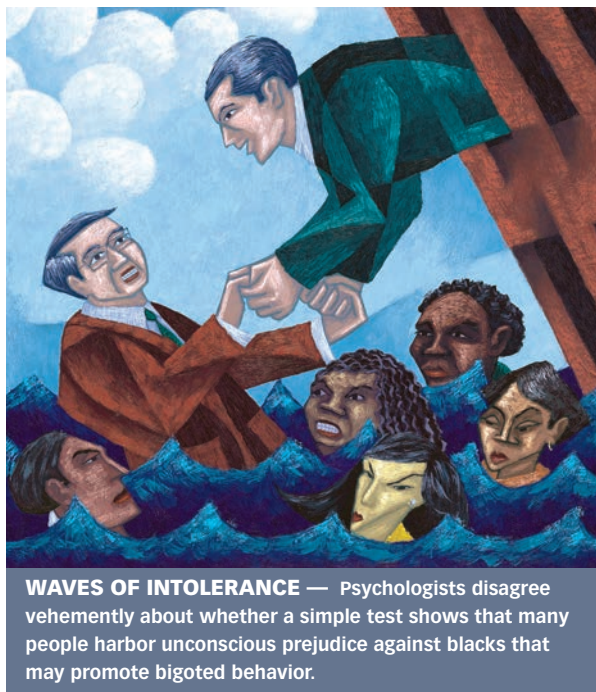
Blanton's team developed a test to examine that prospect. The researchers separately assessed the speed with which participants associated typical African-American names with positive words, African-American names with negative words, European-American names with positive words, and European-American names with negative words. In each instance, participants' response speed was compared with the time needed to make neutral associations, such as pairing words for pieces of furniture with synonyms for "middle."

Volunteers who easily paired black names with negative words frequently scored high on a questionnaire probing for negative attitudes about blacks, regardless of how quickly they associated white names with positive or negative words. By contrasting a person's rapid associations to blacks and whites, the IAT may thus hide more than it reveals about simmering racial prejudice, Blanton says.

LOSE THE ATTITUDE Other lines of research portray the IAT as a measure complicated by factors beyond unconscious attitudes.

IAT scores tap into the greater ease of making positive associations when dealing with familiar social categories, according to psychologist Jan De Houwer of Ghent University in Belgium. In a 2001 study, De Houwer administered a British-foreigner IAT to British participants. Volunteers more easily associated British citizens, ranging from the revered Queen Mother to a notorious mass murderer, with pleasant words. In contrast, they more easily linked an array of foreigners, from the celebrated Albert Einstein to the despised Adolf Hitler, to unpleasant words.

(continued on page 253)



OF NOTE

CLIMATE

Antarctic birds are breeding later

As global temperatures rise, Arctic birds are breeding earlier than they did in previous decades. However, the reverse is true in Antarctica, new research shows.

"In the Arctic, spring basically comes earlier, and most species [of migratory birds] respond by arriving and laying eggs sooner," says Christophe Barbraud, an ornithologist at the National Center for Scientific Research in Villiers en Bois, France. But there have been few studies of the phenomenon in the southern hemisphere.

Since 1950, ornithologists in Terre Adélie, Antarctica, have kept careful track of when nine species of seabirds arrive and lay their first eggs. Using those data, Barbraud and his colleague Henri Weimerskirch calculated that the Antarctic birds migrated to the region an average of 9 days later in 2004 than they had in the early 1950s, and they laid their eggs an average of 2 days later.

Temperatures don't appear to be increasing in all of Antarctica, as they are in the Arctic. But temperature changes per se don't explain the Antarctic breeding schedules. Instead, changes to Antarctica's surrounding layer of sea ice may be at least partially to blame, they say.

Since the 1950s, total sea ice around eastern Antarctica has decreased by 12 to 20 percent. At the same time, winters are lasting longer. That combination could be a one-two punch, Barbraud says.

Sea ice shelters krill and other marine organisms that the birds feed on, he says. Less sea ice means less krill, so the birds may need to fatten up before they arrive to breed. And as the sea ice breaks up later because of delayed yearly springs, the birds may also have to wait longer to reach their colonies, the researchers report in the April 18 *Proceedings of the National Academy of Sciences*. —C.G.

PLANETARY SCIENCE

Ice among the rocks

Researchers have found a trio of icy comets hidden among the thousands of rocks in the main asteroid belt between the orbits of Mars and Jupiter. Such comets, which don't

fit into any known class, could have been primary sources of water that transformed the early, dry Earth.

Each member of the trio, dubbed main-belt comets by codiscoverers Henry Hsieh and David Jewitt of the University of Hawaii in Honolulu, appears to have formed inside Jupiter's orbit. That's in contrast to most other comets, which were born beyond Neptune in the chilliest parts of the solar systems.

The existence of the main-belt comets indicates that asteroids and comets—rocks and ice chunks, respectively—could be more closely related than previously proposed. If icy bodies are relatively common in the asteroid belt, they could have provided some of the water delivered to Earth about 4 billion years ago, Jewitt and his collaborators suggest in an upcoming *Science*.

Using the Gemini North Telescope atop Hawaii's Mauna Kea, the team late last fall found that an object, known as asteroid 118401, was spewing an abundance of dust, just as a comet does during its journey toward the sun. Two other known comets, called 133P/Elst-Pizarro and P/2005 U1, show similar behavior and orbits.

Most comets have elongated, tilted orbits relative to the planets' paths around the sun. But, like asteroids, the main-belt comets have circular orbits that lie in the planets' plane. The dust-spewing main-belt comets thus resemble a hybrid of asteroids and comets, the team suggests. —R.C.

BIOMEDICINE

Protein interacts with hormone that quells hunger

A protein that's especially abundant in the blood of obese people inactivates a hormone that controls hunger, according to a new study.

Animals engineered to lack this hormone, leptin, eat more and gain weight, making the hormone an attractive target for obesity treatments. However, notes Allan Z. Zhao of the University of Pittsburgh, obese people typically produce the same concentration of leptin that thin people do.

Zhao and his colleagues suspected that, in obese people, some substance might pre-

vent leptin from stimulating receptors in the brain that affect appetite. After analyzing rat and human blood, the researchers homed in on C-reactive protein (CRP), a substance that's associated with inflammation and has been found in higher-than-normal concentrations in obese people. From test tube experiments, the team found that CRP binds to leptin and prevents it from reaching its receptors.

In a different experiment, the researchers gave leptin to mice that were engineered not to produce the hormone. As expected, the animals then ate less and lost weight. However, when the scientists administered the hormone along with CRP, leptin had no discernible effect on the

rodents' appetites or weight.

Zhao's team suggests in the April *Nature Medicine* that preventing leptin from interacting with CRP may provide a new way to treat obesity. —C.B.

ZOOLOGY

Worm can crawl out of predators

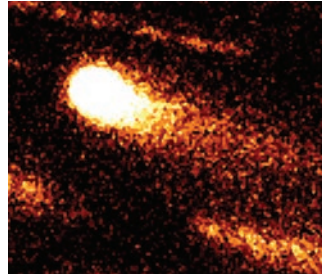
A Gordian worm grows up inside an insect, then leads its host to drown itself so the worm can free itself. But, should an aquatic predator get to the insect first, the worm has an escape plan, says an international research team.

This marks the first time scientists have documented this escaping-parasite trick, says Fleur Ponton of the Institute of Research for Development in Montpellier, France.

Typical hosts such as crickets aren't aquatic, but the worms make them so erratic that they hop into water. The crickets eventually drown, but the parasite escapes into the water, its natural adult environment, to breed.

Once the cricket hits the water, the worm needs about 10 minutes to wriggle free. During this interlude, the cricket makes an attractive target for frogs, fish, and other predators. If something eats the cricket, the worm just keeps on wriggling until it emerges through the predator's mouth or gills (www.sciencenews.org/articles/20060422/frog.mov), Ponton and her colleagues report their findings in the April 6 *Nature*.

The researchers recorded more than 20 worm escapes from trout, 6 from perch, and 6 from frogs. —S.M.



CURIOUS COMET One of the three newly discovered main-belt comets (center), which have properties in common with both main-belt asteroids and comets from farther out in the solar system. Also visible are smeared images of stars and galaxies.

(continued from page 251)

“No one should be provided with the kind of feedback given daily to visitors of IAT Web sites.”

— HART BLANTON,
TEXAS A&M UNIVERSITY

The investigators found that while most white volunteers displayed implicit bias against blacks on a traditional IAT, far fewer displayed implicit bias on the personalized test.

Even more disturbing is preliminary evidence that people can easily fake their IAT scores. In a 2005 study, Klaus Fiedler of the University of Heidelberg in Germany administered an IAT of implicit attitudes toward Germans and Turks to 198 German volunteers. He then asked participants to retake the test and fake their responses but offered no specific instructions on how to do so.

Most people reversed their IAT scores, usually by hesitating before responding to associations that they had previously made more quickly. Two experienced IAT testers who examined the results found it nearly impossible to identify IAT fakers, Fiedler says.

LEGAL STAKES Scientific conclusions about the IAT have the potential to reverberate through law and politics. Consider the fate of affirmative action programs.

In 2003, Supreme Court Justice Sandra Day O'Connor wrote that in 25 years affirmative action would no longer be needed. Harvard's Banaji and law professor Jerry Kang of the University of California, Los Angeles hold that no date can be specified today. Affirmative action and other measures to rectify discrimination should end “when measures of implicit bias for a region or nation are at zero or some rough behavioral equivalent,” Kang and Banaji write in an upcoming *California Law Review*.

Average IAT scores of big chunks of the U.S. population provide a reasonable estimate of the societal reach of racial discrimination, which remains disturbingly common, they assert.

The IAT can neither read minds nor solve the sticky affirmative action debate, responds psychologist Philip E. Tetlock of the University of California, Berkeley. He and law professor Stephen Mitchell of Florida State University in Tallahassee cite research by Blanton and others to argue that, in many cases, IAT scores reflect emotional reactions that have nothing to do with antiblack sentiment.

Many people react to black faces or names on an IAT test with compassion and guilt over African-Americans' past and current plight, a response that could slow their speed in associating blacks with positive words just as surely as deep-seated hostility toward African-Americans could, Mitchell and Tetlock suggest. IAT researchers have yet to explore this possibility.

Blanton greets any application of the IAT with trepidation. “IAT scores can't be meaningfully interpreted,” he says. One of his students, a biracial woman raised by her white mother, was extremely upset by her IAT score indicating implicit antiblack bias, although her score could have easily reflected greater familiarity with whites than blacks, Blanton notes. “No one should be provided with the kind of feedback given daily to visitors of IAT Web sites,” he says.

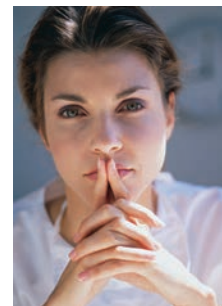
Although Nosek upholds the test's value, he says that there are still “many unresolved issues about the nature of the IAT and its potential for revealing disquieting aspects about human minds.” ■

The IAT's focus on linking racial groups to general “pleasant” and “unpleasant” categories also taps into cultural knowledge about those groups, such as awareness that blacks are often portrayed negatively in news stories and movies, says psychologist Russell H. Fazio of Ohio State University in Columbus.

Volunteers score lower on implicit racial bias if their associations concern only personal preferences, Fazio contends. In a 2004 investigation, he and his Ohio State colleague Michael A. Olson developed a “personalized IAT,” which required associating black and white names with positive or negative words under the headings either of “I like” or “I don't like.”

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MEETINGS

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MICROBIOLOGY

RNA test might reveal early cancer, offer drug target

By analyzing snippets of genetic material called microRNAs in the intestinal cells of people with colorectal cancer, researchers have devised a technique that might reveal which cancers are at the highest risk of recurrence. The finding could also open the way for new drugs targeting aberrant microRNAs that contribute to the malignancy.

Certain genes carry the blueprints for microRNAs. The scientists compared the activity pattern of 248 such genes in healthy colon tissue with those in cancerous tissue. The scan revealed 16 of these microRNA genes whose behavior was different in the two tissue categories.

The researchers then studied the fast-growing cells that line the colon and that are normally sloughed off and replaced every 5 days or so. These cells are generated in pockets embedded in the lining of the colon called crypts, says Bruce Boman, a physician and geneticist at Thomas Jefferson University in Philadelphia.

Stem cells that reside deep within these crypts divide and spin off a regular supply of daughter cells, which then differentiate as needed to replace the colon-lining cells. Boman and his team tested the activity of the 16 microRNAs in cells from deep within these crypts. They found that their test correctly predicted whether cells from these crypts were cancerous or healthy, Boman says.

Scientists are still deciphering the normal job of microRNAs. Research has shown that they influence whether many genes are activated or silenced. "It may be that microRNAs regulate genes that prevent stem cells from dying or [regulate] other genes that keep the stem cells active and proliferating," Boman says.

As such, these microRNAs might influence the size of the stem cell population. "Colorectal cancer may be a disorder of too many stem cells. If stem cell self-renewal requires regulatory mechanisms based on microRNA, then maybe you can target those mechanisms for colorectal cancer treatment," says Boman.

Many colorectal cancer patients have surgery that appears to remove all of their cancer, only to have it crop up again later. The microRNA test might enable scientists to predict which patients have overactive stem cells in their colon lining and thus are at high risk of a cancer recurrence, Boman says.

Moreover, microRNAs "are going to be excellent candidates for targeted therapeutics," he says. Devising compounds that interfere with the aberrant microRNAs might derail the impetus to spur cancer-stem cell growth. —N.S.

BIOMEDICINE

Hot-pepper ingredient slows cancer in mice

Capsaicin, the compound that gives hot chili peppers their zip, kills cancer cells in a test tube and slows the growth of pancreatic and prostate cancers in mice, two studies show.

A University of Pittsburgh Medical School team led by biochemist Sanjay K. Srivastava implanted pancreatic tumor cells from people into mice. The same day, some of the mice began receiving oral doses of capsaicin while the others got saline solution.

After 38 days, tumors in the capsaicin group were half the size of the tumors in the mice getting saline.

Although spicy, the capsaicin didn't cause any gastrointestinal problems, says Srivastava.

In a similar study, researchers at Cedars-Sinai Medical Center and the University of California, Los Angeles implanted human prostate-tumor tissue in mice. Some of the animals subsequently received capsaicin orally while others didn't. After 4 weeks, the tumors in mice getting the capsaicin were only one-fourth the size of tumors in the other mice, the scientists report in the March 15 *Cancer Research*.

The findings are provocative because this particular prostate cancer came from "quite an aggressive cell line," says study coauthor James O'Kelly, a pathologist. "But we're not advocating that people start eating a lot of hot peppers to treat their prostate cancer," he says.

Both teams of researchers became interested in capsaicin after Japanese researchers reported 5 years ago that the compound killed leukemia cells in test tubes. Similar lab tests by Srivastava's

group indicate that capsaicin induces suicide by tumor cells, while O'Kelly and his colleagues found signs that the compound stifled cell proliferation in some tests and induced cell suicide in others. —N.S.

DIAGNOSTICS

A better test for lung cancer?

A new test might enable doctors to catch lung cancers that are missed by a commonly used diagnostic tool.

Each year in the United States, about 300,000 people get a chest X ray that shows a suspicious spot in a lung. That's enough to warrant a bronchoscopy, in which a doctor inserts a lighted, flexible scope down a person's windpipe to visually examine the cells. "The procedure detects cancer in about 75,000 of these patients,

but twice that many are ultimately diagnosed with lung cancer, some after years of follow-up," says Avrum Spira, a pulmonary care physician at Boston University School of Medicine.

To more quickly detect cancers that are missed by bronchoscopy, Spira and his colleagues scanned 22,500 genes in lung-lining cells and found that 80 are inordinately active or quiescent in cancerous cells compared with their behavior in normal cells.

To test whether this unusual genetic signature could predict cancer, Spira and his team enrolled 152 current and former smokers who had suspicious chest X rays. Each underwent a bronchoscopy.

During the procedure, the researchers collected cells lining the windpipe to use for the genetic-signature test.

A final cancer determination was made after several months of follow-up and, in some cases, open-lung biopsy. The bronchoscopies had detected roughly half of the cancers in the group, and the genetic signatures of the windpipe cells had revealed 80 percent.

"By adding this test to the [bronchoscopy] procedure, we picked up almost 90 percent of the lung cancer cases," Spira says. The genetic test was especially good at catching cancer in an early stage, when it is most treatable.

Affymetrix of Santa Clara, Calif., which funded the study, has the patent for the genetic test. —N.S.



HOT STUFF The compound capsaicin, which makes hot chili peppers spicy, kills cancer cells in a lab dish and thwarts the growth of pancreatic and prostate cancer in mice.

Books

A selection of new and notable books of scientific interest

LETTERS TO A YOUNG MATHEMATICIAN

IAN STEWART

The pursuit of mathematics as a profession, unlike that of law or medicine, is an underappreciated endeavor, writes Stewart, a professor of mathematics. Here he provides advice to students who nevertheless see math as their calling. In a series of letters addressed to a fictional budding mathematician named Meg, Stewart considers some of the common challenges faced by people studying math whether as high school students or tenured faculty. An important decision for all these math enthusiasts is the choice of whether to focus on pure or applied mathematics. Stewart advises that young mathematicians do both. He also addresses how mathematicians think and what they require as proof in their work. This book is a guide for people seeking to survive at all levels of the often-eccentric mathematical community. *Perseus, 2006, 224 p., hardcover, \$22.95.*



NATURE REVEALED: Selected Writings, 1949-2006

EDWARD O. WILSON

Wilson is a pioneer in studies of sociobiology and biodiversity. This new collection of essays starts with his first published work, on the fire ant, which originally appeared in 1949 when Wilson was a 19-year-old senior at the University of Alabama. The book includes 60 other essays covering Wilson's career until the present day. They appear exactly as first published in journals, books, and magazines such as *Scientific American*. Each essay is preceded by a short introduction explaining the context of the piece and what the author and other scientists were thinking about and exploring at the time of its publication. Wilson discusses topics as diverse as evolutionary biology, ecology, and behavioral biology. Wilson has won two Pulitzer Prizes, the first for his 1979 book *Human Nature* and the second for his 1991 book *The Ants*. Neither of those works is excerpted in this volume, however. *Johns Hopkins University Press, 2006, 736 p., hardcover, \$35.00.*



WINDSWEPT: The Story of Wind and Weather

MARQ DE VILLIERS

The wind, whether it's a gentle breeze or a destructive gale, has a presence that can seem almost personal. Indeed, throughout human history, people ascribed to wind godlike power and great malevolence. The wind carries away excess heat, making life more comfortable, and serving as the driver of the planet's system of weather. De Villiers chronicles the history of people's attempt to understand the wind and weather, tying together each chapter with an account of 2004's Hurricane Ivan, the category 5 storm that ravaged the East coast from Texas all the way to the author's home in Nova Scotia. The tempest began as a mere rainstorm in Darfur, Sudan, and then

grew. From Homer's four winds to the discovery of air-circulation patterns during the World War I, the movement of air has captured the minds of philosophers and scientists for centuries. In clear language, de Villiers describes how wind forms, what forces affect the movement of air masses, and how air coalesces into vortexes, including tornadoes and hurricanes. He addresses the many ways that plants and animals, including people, exploit the power of the wind and discusses how global warming is changing the atmosphere. The book concludes with several useful appendices. *Walker, 2006, 352 p., hardcover, \$25.00.*



QUANTUM MECHANICS DEMYSTIFIED: A Self-Teaching Guide

DAVID MCMAHON

Quantum mechanics is one of the more obscure areas of physics. McMahon tackles this difficult, highly mathematical subject in his straightforward guide to the latest quantum mechanical theories. Though the book advises readers to have a background in physics and calculus and a working knowledge of complex numbers and vectors, physicist McMahon clearly defines the notions of blackbody radiation, the photoelectric effect, the Schrödinger equation, and vector space. Divided into three parts, the book provides a brief review of quantum theory basics, and the mathematical foundations of modern quantum mechanics. It provides illustrations of the use of quantum theory. The last section of the book deals with angular momentum and spin, the harmonic oscillator, and the physics of the hydrogen atom. Not for the mathphobic, this book nevertheless offers a jargon-free guide to a complex field. *McGraw Hill, 2005, 393 p., paperback, \$19.95.*



MADE TO BREAK: Technology and Obsolescence in America

GILES SLADE

Each year, consumers replace old but still-functioning cell phones, televisions, computers, and other electronics items with newer, sleeker models. The discarded items end up in landfills, where they slowly leach their toxic components. Slade examines how obsolescence became a way of life in the United States. He describes the various forms of obsolescence—technological, psychological, and planned—and how businesses have exploited them to increase profits. Early in the 20th century, manufacturers discovered that consumers value convenience, such as battery-powered car ignitions in place of hand cranks, and that people would purchase new products solely on the basis of style and packaging changes. Slade examines the era of planned obsolescence, which developed during the Great Depression as a way for companies to increase sales and revenues. The practice became common during the 1950s and 1960s, writes Slade, as a competitive tactic between Ford and General Motors. Finally, the book details the current era of "e-waste"—short-lived components in now-ubiquitous handheld gadgets. This latest phase of planned obsolescence is creating overwhelming mounds of waste that cry out for environmentally friendly products. *Harvard, 2006, 336 p., hardcover, \$27.95.*



LETTERS

Second cousins

With reference to "Chimps creep closer yet" (*SN: 2/11/06, p. 94*), some scientists say that bonobos are genetically closer to humans than to chimps. How did they compare in the referenced study?

DICK MEDVICK, CLEVELAND HEIGHTS, OHIO

Bonobos are indeed as genetically close to humans as are chimps, but there wasn't enough genomic data available for bonobos to include them in the study, says evolutionary biologist Soojin Yi of the Georgia Institute of Technology. —C. GRAMLING

Why me?

Some of the descriptions about confusion of self ("Self-Serve Brains: Personal identity veers to the right hemisphere," *SN: 2/11/06, p. 90*) were very reminiscent of the confusion I often sense in dreams. I even recognize in some dreams the sensation described in the article about various body parts not being part of "me." I wonder if this aspect of normal (I assume) dreaming has been investigated.

STANLEY E. ANDERSON, WESTMINSTER, CALIF.

It surprises me that none of the researchers mentioned in your article considered the possibility that the essential sense of self is an extremely primitive aspect of brain function. An animal could not protect itself from predators or physical dangers unless it had a well-developed sense of personal being.

ALEX HEYDON, AJAX, ONTARIO

Researcher Todd Feinberg of Beth Israel Medical Center in New York raises the possibility that disordered selves represent a kind of "waking dream" in his book Altered Ego: How the Brain Creates the Self (2001, Oxford Univ. Press, New York). Feinberg argues that a primitive sense of self occurs in many animals. —B. BOWER

Think thin

So, researchers studying the effects of the hunger hormone ghrelin have found that hungry mice do better on tests of learning and memory ("Hunger for Knowledge: Appetite hormone may stimulate memory," *SN: 2/25/06, p. 118*). Four hundred years ago, William Shakespeare had Julius Caesar say, in Act I, Scene II, "Let me have men about me that are fat; Sleek-headed men and such as sleep o' nights. Yon Cassius has a lean and hungry look; He thinks too much. ..."

MERLE HETLEY, BANGOR, MAINE

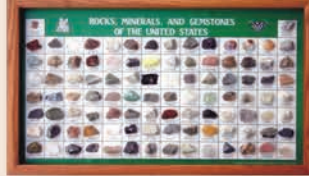
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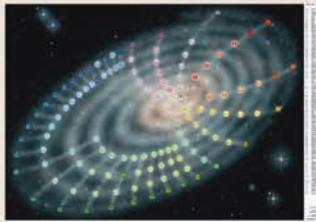
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