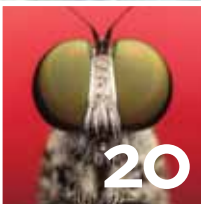


Year 2016 | Volume 14 | Health | Natural Science | Technology | Social Science | Humanities | Business

Research *at* Penn



18



20



28



Moving Knowledge Forward



Vincent Price
Provost



Dawn Bonnell
Vice Provost for Research

Penn is energized by exploration. Every day, its researchers are uncovering something new. Through cutting-edge discoveries in health to the humanities, they are finding ways to address and solve the biggest challenges in our local, national, and global lives.

This brochure is an effort to highlight some of the eminent research across the University's 12 schools from the past year.

These experts are not afraid to challenge traditional paradigms. They ask if we've been unnecessarily over-sedating sick children in the intensive care unit, if the elimination of food deserts actually leads to healthy eating, and whether having a glass or two of wine every night is actually harmful to heart health.

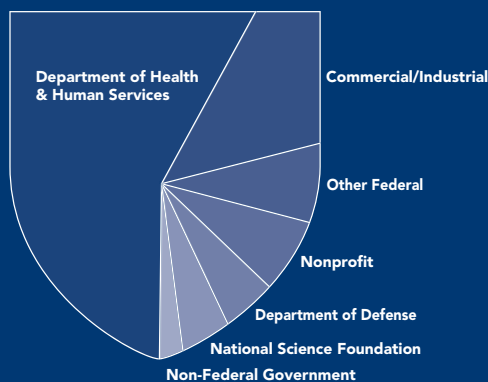
A group of medical doctors are combating cancers with innovative therapies, while a historian is publishing research on why Americans lack constitutional rights at work. One researcher is uncovering ways to use wearable sensors to detect illegal firearm use, and another is helping the School District of Philadelphia unveil an effective dual language program for elementary learners.

At Penn, research is aimed at expanding the frontiers of human achievement and understanding, with the ultimate goal of improving the world.

To keep up with all the University's research news, visit Penn's research website: upenn.edu/researchdir.

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PHOTO CREDITS Health / Conquering Cancer / Page 6
John Donges

Natural Science / Q&A / Table of contents, pages 8–9
Scott Spitzer

Natural Science / Dinosaur / Table of contents, pages 10–11
Liu Qinxue

Natural Science / Earth's Twin / Pages 14–15, back cover
Courtesy of David Sliski

Technology / 'Digital' Metamaterials / Table of contents, page 19
Ella Marushchenko and Alex Tokarev

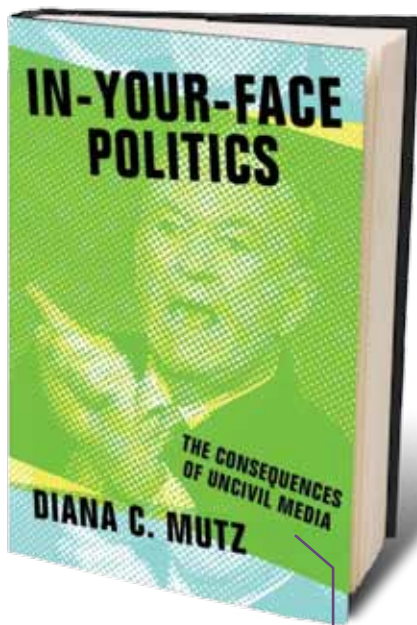
Technology / Compound Eyes / Page 21
Courtesy of Francesca Serra

Humanities / Digital Alliance / Page 29

Martin Grandjean, www.martingrandjean.ch/wp-content/uploads/2013/10/Graphe3.png

8

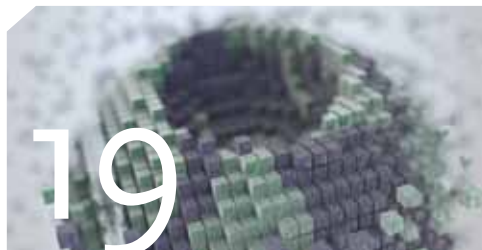
What's Inside



2
Some of the patients who participated in a Penn clinical trial for a personalized cellular therapy have had what researchers say are “astounding” responses.



10
Remains of 25 young dinosaurs were found in a single rock slab in northeastern China.



19
Metamaterials involve precisely designing composites with unnatural electromagnetic properties.



24
Wearable sensors may transform the correctional system by tracking firearm use.

5
Patients Receive Too Much Radiation

U.S. women treated for early-stage breast cancer receive longer radiation therapy than necessary.

27
Incivility in a Civil Society

Discourse on political television is more heated than normal conversations.

28
Essays and Poems from Kashmir

Reflecting on the nature of life and experiences in a conflict zone.

31
Searching for Respect in Sports

The challenge of true diversity and inclusion in the sports world.

ON THE COVER: Alison Sweeney studies the giant clams of Palau, biological structures that are exquisite manipulators of the electromagnetic spectrum.

BACK COVER: Astronomers are using the telescope MINERVA-Red to examine small, cool stars.



After exhausting all conventional treatments, a group of leukemia patients had few—if any—options left. They were considered likely untreatable, and were expected to die from their disease.

Then, a new investigational treatment option came along. Some of the patients who participated in a Penn clinical trial for a personalized cellular therapy known as CTL019 throughout the last five years have had what researchers say are “astounding” responses.

“Two of our first patients hit the five-year mark in summer 2015 and have no detectible signs of relapsed/refractory chronic lymphocytic

leukemia [CLL]” says David Porter, the Jodi Fisher Horowitz Professor in Leukemia Care Excellence and director of Blood and Marrow Transplantation in the Abramson Cancer



Center. “With conventional therapies, relapses beyond five years aren’t typical. Getting to five years is a really remarkable achievement.”

Porter is still hesitant to use the word “cure” because he doesn’t know what the future holds, but says, “it eradicated all measures of leukemia in those two patients when nothing else helped.”

A treatment developed by a team from the Abramson Cancer Center and Penn’s Perelman School of Medicine, CTL019 cells are created by removing a patient’s own T cells, a form of white blood cell, and then genetically modifying them to target specific types of cancer cells. The CTL019 “hunter” cells are infused into a patient’s body, where they may multiply and potentially attack cancer cells. The initial trials have been directed at B cell leukemias and lymphomas.

About half of the CLL patients who received CTL019 have responded to the therapy. The responses to the personalized cellular therapy have been even more dramatic in relapsed/refractory acute lymphoblastic leukemia patients. Data presented at the annual meeting of the American Society of Clinical Oncology

KICKING Combating the Incurable with Personalized Cellular Therapy CANCER

in June 2015 indicated that 45 of 48 patients in this group who were treated with CTL019 experienced complete remission (a 94 percent complete response rate).

The new therapy doesn't come without risk. Many of the patients who received CTL019 experienced a serious adverse event called cytokine release syndrome (CRS) within a few days of receiving their infusions. CRS may occur when the engineered cells become activated and multiply in the patient's body, resulting in the release of cytokines. During CRS, patients typically experience varying degrees of flu-like symptoms with high fevers, nausea, muscle pain, and in some cases, low blood pressure and breathing difficulties.

The research team is co-led by Porter and Carl June, the Richard W. Vague Professor in Immunotherapy in the Department of Pathology and Laboratory Medicine and director of translational research at the Abramson Cancer Center. In July 2014, their personalized cellular therapy received the U.S. Food and Drug Administration's Breakthrough Therapy designation.

"When patients receive these cells, they're getting a living drug that can grow in the body," Porter explains. "It's unlike chemo or a pill."

"When patients receive these cells, they're getting a living drug that can grow in the body."

According to Porter, this treatment also has the potential to target other types of cancers besides leukemia and lymphoma.

"We now have similar clinical trials with brain cancer, lung cancer, ovarian cancer, and pancreatic cancer," he says.

Related studies have been supported by Novartis, the Conquer Cancer Foundation, National Institutes of Health, the Leukemia & Lymphoma Society's Specialized Center of Research Program, and Stand Up to Cancer – St. Baldrick's Pediatric Dream Team. ■

A FACTOR IN DIABETICS' POOR WOUND HEALING



In diabetics, wounds can take a long time to heal. In some cases, these wounds can lead to one of the more fearsome complications of the disease: amputation.

While it's known that elevated blood sugar levels and immune system deficiencies contribute to poor wound healing, the underlying molecular pathways involved are unknown and thus, non-healing wounds remain difficult to treat.

Dana Graves, a professor of periodontics and vice dean for scholarship and research in Penn's School of Dental Medicine, has long studied wound healing. In work published in the *Journal of Cell Biology* examining skin wounds and in *Diabetes* on mucosal wounds, he and colleagues found that a molecule called Foxo1 plays a critical, unexpected role in wound healing. Their findings point to potential drug targets that may speed healing in diabetics.

Earlier work by Graves' team suggested that Foxo1 promoted healing, contradicting other scientists' studies that found that the same molecule could slow the process. In the new studies, supported by the National Institute of Dental and Craniofacial Research, the research team aimed to shed light on the anomalous findings.

They examined wound healing in mice with diabetes that had been bred to lack Foxo1 in their keratinocytes—skin cells that mobilize to cover wounds—and found that a wound in diabetic mice actually healed faster if Foxo1 was deleted. But in normal mice, deletion of Foxo1 in keratinocytes displayed the opposite effect—their wounds healed more slowly.

Further experiments examined how Foxo1 affected cell movement and proliferation, which are key processes in healing. While both processes were suppressed in diabetic mice, those with keratinocytes that lacked Foxo1 didn't show the same deficits. The team was able to explain this difference by showing that Foxo1 regulates a different set of signaling molecules involved in cell movement depending on whether an animal is normal or diabetic. In normal mice, the Foxo1 protein stimulates expression of genes that promote wound closure, while in diabetic mice, the same protein induces genes that interfere with healing.

"In terms of a wound-healing response, it looks like Foxo1 might be one of the central regulators that are affected by the diabetic condition," Graves says. "This may make it a good target for a drug that could be administered locally in diabetic wounds to minimize systemic effects." ■



Drinking Alcohol Provides No Benefits to Heart Health

There's a popular notion that suggests that alcohol consumed in small amounts poses little risk to one's cardiovascular health—and may even enhance it, in the case of a glass or two of red wine.

But recent work published in *The British Medical Journal* from Michael Holmes, a research assistant professor of surgery in Penn's Perelman School of Medicine, shows that consuming alcohol, even in light-to-moderate amounts, is actually far from beneficial. In fact, reducing the amount of alcohol one consumes lowers the risk of coronary heart disease, Body Mass Index (BMI), and blood pressure.

The earlier studies about alcohol are based on research that looked at only how much people drank. Those observational studies can be biased and give misleading results, explains Holmes.

His work, conducted with the help of Brendan Keating, research assistant professor of pediatrics at Penn Medicine, and financial support from the British Heart Foundation and Medical Research Council, amassed data from more than 50 other studies that linked drinking habits and cardiovascular health for upward of 260,000 people. They found that individuals who carry a specific gene that typically leads to lower alcohol consumption over time are generally in better cardiovascular health. Specifically, individuals who consume 17 percent less alcohol per week have about a 10 percent reduced risk of coronary heart disease, as well as lower blood pressure, markers of inflammation, blood cholesterol levels, and BMI.

"These new results are critically important to our understanding of how alcohol affects heart disease,"

CONTINUED ON PAGE 33

> CHALLENGING NORMS <



Children Can Be Awake, Yet Comfortable, in ICU

Martha Curley isn't afraid of challenging traditional paradigms. She's one to question a longtime practice, and provide evidence supporting a solution.

That's what she's done in a recent study, known as "RESTORE." Curley, the Ellen and Robert Kapito Professor in Nursing Science in Penn's School of Nursing, has collected data that suggest intensive care clinicians may be unnecessarily overly sedating children in the intensive care unit.

"The norm of the care environment is that when a child is critically ill, they are kept comfortable and sometimes that includes unconsciousness," Curley says, which also keeps them from instinctively trying to remove a variety of connected tubes and monitors.

But it can involve a slew of repercussions.

"It makes a patient lay in the bed without moving as normal, so that he or she may end up with pressure ulcers, or pneumonia caused by the respirator," Curley says.

Through RESTORE, Curley and her team found that the majority of these adverse effects could be eliminated if children are simply kept on a lighter, more finely tuned level of sedation. They say children can indeed be awake, yet comfortable, in the ICU.

Curley's study, which examined children from 2 weeks to 18 years of age with acute respiratory failure, was supported by a grant from the National Heart, Lung, and Blood Institute. It was published in the *Journal of the American Medical Association*.

A total of 31 ICUs across the country were part of the study, half of which participated in the intervention, where nurses would titrate the sedation based on the immediate needs of the child. The other half continued usual care.

"We thought we'd see a decrease in the length of mechanical ventilation," Curley says. "Instead we saw no difference. But since all the secondary outcomes, like comfort levels, were improved, in my sense RESTORE improves the fundamental quality of care these patients received. In that regard, it was a very positive study."

Now Curley is leading a longitudinal study dubbed RESTORE-Cognition, in which she will try to better understand the long-term effects of sedation on pediatric patients.

"There are a lot of physical and cognitive incapacities after critical illness, referred to as post-intensive care syndrome," Curley says. "We know that occurs in adults, but not necessarily in children. With RESTORE-Cognition, we will be able to identify whether or not kids have similar outcomes after a critical illness." ■

U.S. Women with Early-stage Breast Cancer Receive Unnecessarily Long Radiation



HEALTH / ONCOLOGY

Penn research shows that two-thirds of women treated for early-stage breast cancer in the United States receive longer radiation therapy than necessary. Instead of receiving conventional whole breast radiation for six to seven weeks, women can undergo less but higher doses of radiation, dubbed hypofractionated

whole breast radiation, and get back to their daily lives in just three weeks. It's also a cheaper option.

"The shorter radiation still has the same survival benefits," explains Justin E. Bekelman, an associate professor of radiation oncology, medical ethics, and health policy at Penn's Perelman School of Medicine and Abramson Cancer Center. "It is no more toxic. It helps patients put their treatment behind them faster. That's something that really matters to patients."

Bekelman and fellow researcher Ezekiel Emanuel, chair of Penn's Department of Medical Ethics and Health Policy and a breast oncologist, published their findings in the *Journal of the American Medical Association*. The study was supported by Anthem, Inc. and grants from the National Cancer Institute.

They garnered data by examining commercial health care plans spanning the period from 2008 through 2013. The researchers analyzed 9 million claims to find women with early-stage breast cancer who had hypofractionated therapy versus those who did not.

Bekelman and Emanuel found that there has been an uptick in using the shorter therapy in the United States since 2008, but it occurs at a much smaller rate when compared to other countries. In 2013, for example, only 34.5 percent of American women more than 50 years old received hypofractionated therapy. Among younger women and those with more advanced cancers, 21.1 percent received hypofractionated therapy that same year.

In Canada, more than 70 percent of women received hypofractionated therapy versus conventional—and that was in 2008. In the United Kingdom, the National Institute for Health and Care Excellence released guidance recommending it as a standard of care in 2009.

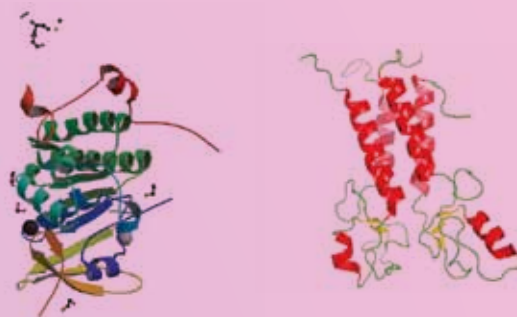
"Health reform in the U.S. is focused on increasing quality of care for patients and lowering the costs," Bekelman says, "and we've identified a treatment

Researchers found that there has been an uptick in using the shorter therapy in the United States since 2008, but it occurs at a much smaller rate when compared to other countries.

that's more patient-centric and with similar outcomes, that's cheaper and more convenient—yet it's not used frequently."

This study identifies the problem, but "it doesn't tell us how to solve it," Bekelman says. That's the next step for his research. ■

DETERMINING HOW CANCER RISKS DIFFER BY BRCA1 OR BRCA2 MUTATION TYPE



Human genes BRCA1 and BRCA2 produce tumor suppressor proteins, which help repair damaged DNA and keep breast cells growing normally. When either of these genes is mutated, it can lead to cancer.

A study published in the *Journal of the American Medical Association*, led by researchers at the Basser Center for BRCA, Perelman School of Medicine, and Abramson Cancer Center, suggests that some mutations based on type and location are associated with significantly different risks: Some lead to higher risks of breast cancer, while other mutations are linked with higher risks of ovarian cancer.

Prior to this study, little had been known about how cancer risks differ by BRCA1 or BRCA2 mutation type.

Researchers conducted a large study involving 31,000 women carrying BRCA1 or BRCA2 mutations. The patients were from 55 centers in 33 countries on six continents.

The study's results, Penn researchers say, provide important information that can lead to more effective cancer risk assessment, care, and prevention strategies for patients and health care providers. ■

Conquering Cancer by Making Tumors Glow

In cancer patients, removing the tumor is an excellent way to prevent the disease from returning. But that is easier said than done. Up to half of patients who undergo surgery to remove their cancer have local recurrences of the disease.

To help surgeons distinguish normal from cancerous tissue, a Penn-led team identified a strategy that sounds like science fiction: making cancerous tissue glow bright green.

“Surgeons have had two things that tell where a cancer is during surgery—their eyes and their hands,” says David Holt, first author on the study and a professor of surgery in Penn’s School of Veterinary Medicine. “This technique is offering surgeons another tool.”

The work, a collaboration between Penn Vet and the Perelman School of Medicine, used a dye called indocyanine green, or ICG, that preferentially accumulates in cancer tissues and fluoresces green under near-infrared light (NIR).

ICG was approved by the U.S. Food and Drug Administration in the 1950s and has been used to study cardiac and kidney function by tracking blood flow.

“Our work uses an old dye in a new way,” says Sunil Singhal, senior author and an assistant professor of surgery in Penn Medicine.

The researchers tested the approach in mice and found that they could use ICG and NIR to distinguish tumors from normal lung tissue more than a week before the tumors were visible to the human eye.

Then they moved to dogs, whose biology more closely resembles humans. With permission from the animals’ owners, they gave eight dogs that had naturally occurring cancer intravenous ICG before surgery at Penn’s Ryan Veterinary Hospital. Using NIR during the operations, the surgeons could rapidly tell cancer tissue apart from normal tissue.

Their study culminated with a clinical trial in humans conducted at the Hospital of the University of Pennsylvania, using a similar protocol to the canine study. The surgeons found that the tumors fluoresced brightly under NIR light. And in one patient, the glowing ICG helped the doctors identify cancer that CT and PET scans had missed.

“We might have otherwise called this Stage I, local disease, and the cancer would have progressed,” Holt says. “But because of the imaging and subsequent biopsy, [the patient] underwent chemotherapy and survived.”

The work was supported by the American Surgical Association and the National Institutes of Health. ■



Financial Incentives to Help Smokers Quit

Smoking remains the leading cause of preventable death in the United States, despite 50 years of warnings from the U.S. Surgeon General, says Scott D. Halpern, an associate professor of medicine, epidemiology, medical ethics, and health policy at the Perelman School of Medicine.

Seventy-five percent of smokers want to quit, but only 2 to 3 percent are successful each year. Halpern, also deputy director of the Center for Health Incentives and Behavioral Economics (CHIBE), says new smoking cessation methods are clearly needed, and one promising approach is to pay people to align their economic interests with their own health promotion.

In the study, “Randomized Trial of Four Financial-Incentive Programs for Smoking Cessation,” co-authored by Kevin Volpp, a professor of medicine and health care management at the Wharton School and Penn Medicine and director of the CHIBE, as well as other Penn Medicine colleagues, they found that four different financial incentive programs, each worth roughly \$800 over six months, were more successful at helping smokers kick the habit than free behavioral counseling and nicotine replacement therapy. The study was published in the *New England Journal of Medicine*.

The study builds off prior research by Volpp that was conducted among 878 employees of General Electric. It found that a bundle of incentives worth about \$750 tripled quit rates.

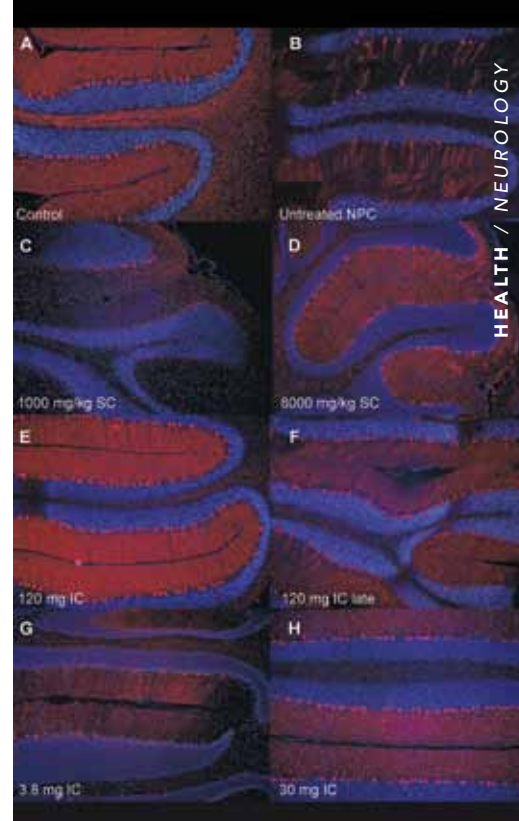
The new study—an eight-month randomized trial among 2,538 CVS employees from across the United States—sought to determine whether programs that focused on the individual worked better than those with a team-oriented approach that might leverage people’s competitive instincts. Funding was provided by the National Institutes of Health, the National Cancer Institute, the National Institute on Aging, and in-kind support from CVS Health.

The researchers also questioned whether they could make incentives work better by getting people to “have some skin in the game” by using their own money, Halpern says.

The participants were assigned into one of five groups: individual reward, collaborative award, individual deposit, competitive deposit, or usual care.

Halpern and Volpp found that among people who would have accepted any program offered to them, the deposit contracts in which participants placed money in escrow were twice as effective as simple rewards, and five times more effective than providing information about the benefits of cessation and free nicotine replacement therapy.

To get more people to sign up, the researchers are partnering with CVS Health for the “700 Good Reasons” trial program. Employees at the company who smoke can deposit \$50 into an account and if they test negative after 12 months, they receive \$750. ■



A treatment for NPC greatly reduced cholesterol in Purkinje cells—neurons responsible for motor control—in cats with the disease.

Treating a Rare Disease in Cats, Then Kids

The first signs of Niemann-Pick Disease type C, or NPC, may be innocent enough: a spell of clumsiness on the playground, or a sudden difficulty in the classroom. But these symptoms foretell a terrible disease.

“These are normally functioning kids until they reach school age,” says Charles Vite, an associate professor of veterinary neurology in Penn’s School of Veterinary Medicine. “Then they start to have trouble with learning. Some of them develop motor disturbances, some can’t talk well, some of them develop psychosis and seizures.”

Most children with NPC die by the age of 20.

While some drugs are available to treat the symptoms of NPC, no specific, FDA-approved treatment exists. But Vite and colleagues are on track to change that.

In a study led by Vite and published in *Science Translational Medicine*, a compound called cyclodextrin dramatically halted the progression of NPC in cats. The results provided evidence to begin clinical trials in children with NPC, which are in progress. The research was supported by the National Institutes of Health, Janssen Pharmaceuticals, NPC

CONTINUED ON PAGE 33

Q&A

with
Danielle Bassett

NETWORK SCIENCE

NATURAL SCIENCE

Danielle Bassett combines neuroscience with network science, the study of complex interactions of interconnected parts.



Danielle Bassett, the Skirkanich Assistant Professor of Innovation in the School of Engineering and Applied Science, has appointments in both the Departments of Bioengineering and Electrical and Systems Engineering, but her interests spread even wider than that.

It all started when she dropped out of nursing school.

“I did that for a year and a half, until my adviser sat me down and said, ‘Why are you here?’” Bassett says. “At that point, I wasn’t sure why I was there myself.”

Though she ended up as a physics major, her fascination with medicine, and the brain in particular, never dissipated. At the end of her undergraduate career, she was looking for something that could meld these two loves together.

She took a joint position between the University of Cambridge and the National Institutes of Health.

“I ended up having four different advisers: one in math, one in physics, one in psychology, and one in psychiatry—the perfect blend of the subjects I was interested in,” Bassett says.

That path brought her to Penn, where she now combines neuroscience with network science, the study of complex interactions of interconnected parts.

The recipient of a 2014 MacArthur Foundation Fellowship, the “genius” grant is supporting Bassett’s research on the neural dynamics of learning, as well as her outreach work that uses art to teach these concepts to middle and high school students.

Where is network science as a discipline?

Network science is a very new field. It draws from physics, mathematics, computer science, and engineering, but the really unusual thing about it is that although it’s fundamentally very quantitative, it has traditionally been exercised predominantly in the context of social systems. It offers insights into how social networks work, and how information diffuses in social groups, leading to changes in human behavior.

I had not even heard the term until I got to graduate school. It’s also only been very recently that we’ve used network science to begin to understand the brain.

One reason for this newness is that science tends to be very reductionist, typically focusing on individual details and how little pieces work. Network science really flies in the face of that basic reductionism. It suggests that we can’t simplify many scientific problems into individual pieces. We have to look at the whole system and face the true complexity of interactions.

Has the rise of the Internet and social networking influenced this change in thinking?

Definitely. Some of the earliest network science papers were on the structure of the Internet.

What makes a network a network?

In its most basic form, networks are composed of two basic elements: nodes, which are the parts of the system, and edges, which are the interactions between those parts. So, a network is the organization of nodes and edges that forms a web. The fundamental underlying assumption is that by understanding the architecture of the web, you can begin to understand the function of the system.

In the brain, different regions do have specific functions, but none of them can

act in isolation. They all have to share information with each other to enable even the most basic human behaviors. There have to be concerted actions between these regions to walk, talk, or learn.

How is the network science approach to studying learning different?

Traditionally, neuroscientists studied learning by taking an MRI of someone’s brain, having that person learn something, and then taking another MRI to see what changed.

Our approach involves looking at the brain while people are learning, not just before and after. And it turns out that this is a network problem. You want to understand how different parts of the brain are communicating.

We’re especially interested in seeing how those communication networks change. We characterize those reconfigurations and link them to behavior: Which patterns of reconfiguration suggest you’re a good learner or a poor learner? If we can understand that basic relationship between learning ability and the reconfiguration of your brain, then hopefully we can intervene in cases of learning disabilities. We might also be able to craft classroom environments to facilitate greater learning, as well.

What are the differences between better and worse learners?

In one experiment, we had study participants play a series of piano arpeggios while in an MRI machine. It’s similar to the game ‘Guitar Hero,’ where you have to press a button that corresponds to the note on the screen.

While they’re doing this, we take images of their brain every two seconds. From these images, we reconstruct the patterns of communication between the regions of their brain. What we find is that people

CONTINUED ON PAGE 33



The remains of 25 dinosaurs were found in a single rock slab in northeastern China.



Babysitting, Dinosaur-style?



For busy parents, a good babysitter can be invaluable. According to research by Penn paleontologists, dinosaurs may have felt the same way.

Taking a new look at a fossil containing the remains of 24 newborn dinosaurs and one older dinosaur, a team led by Penn’s Brandon Hedrick, who recently earned his Ph.D. from the School of Arts & Sciences’ Department of Earth and Environmental Science, and Peter Dodson, a professor in the department with an additional appointment in the School of Veterinary Medicine, says it’s possible that the group was a clutch of hatchlings overseen by a juvenile “babysitter.” Their work was published in the journal *Cretaceous Research* and supported in part by the National Science Foundation.

The 120-million-year-old rock slab was found in northeastern China’s Liaoning Province by amateur paleontologists. The creatures preserved inside are from the plant-eating species *Psittacosaurus lujiatunensis*.

Examining thin slivers of the rock using a technique called X-ray diffraction, Hedrick, Dodson, and colleagues found that the material likely originated from a volcano, suggesting that the animals may have been caught in a slurry associated with an eruption.

“They were likely trapped by a flow,” Hedrick says, “though we can’t say exactly what kind of flow.”

The paleontologists say several signs support the idea of the older dinosaur being a caretaker of the younger ones. First, the 24 smaller animals were of similar size, suggesting they could be hatchlings, still in a nest. The skull of the larger psittacosaur was embedded in the same layer of rock as the smaller ones, and even intertwined with some of the smaller animal’s skeletons, indicating they were in the same place at the time of their burial. And finally, the larger animal’s skull, about 4.5 inches long, suggests it was about 4 or 5 years old—definitely older than the other animals but probably several years younger than the age of a sexually mature psittacosaur—suggesting that it was not one of the hatchlings’ parents.

Rather, the researchers say this may have been an older brother or sister caring for its siblings, a characteristic shared by some of dinosaurs’ descendants: modern-day birds. ■

THE BRAIN'S MAP AND COMPASS



For an organism to orient itself, it needs both a map and a compass to know where it is and which way it is facing. Humans have increasingly good technological versions of these tools, but brains are naturally adept at gleaning this information from the environment, as well. How this feat is actually accomplished, however, remains poorly understood.

Penn researchers have shown that mental map and compass systems work independently.

The study, published in the *Proceedings of the National Academy of Sciences*, was conducted by graduate students Joshua Julian and Alexander Keinath, assistant professor Isabel Muzzio, and professor Russell Epstein, all of the Department of Psychology in the School of Arts & Sciences. It was supported by the National Science Foundation and the National Institutes of Health.

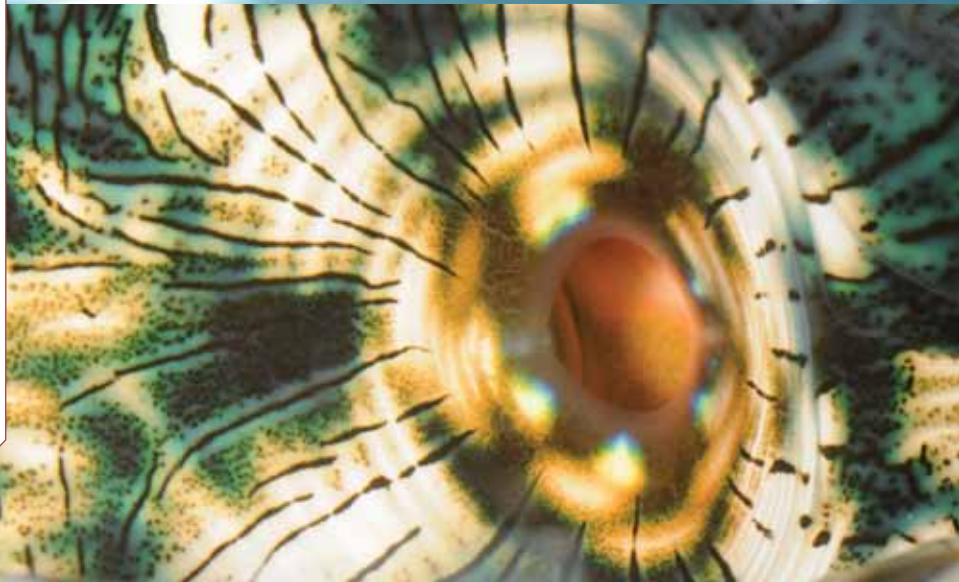
The team's study was an updated version of one of the original studies of reorientation. That experiment involved repeatedly putting rats in a rectangular room that had food hidden in the same corner each time. Markings on the walls should have enabled the rats to tell which corner had the food, but they were just as likely to look in the corner diagonally across from it. This told the researchers that the rats' "compasses" were calibrated exclusively to the geometry of the room's long and short walls. They apparently couldn't use the markings to tell which corner was which.

"These earlier reorientation studies taught us how the mental compass worked," Julian says, "but did not tell us about the mental map."

In the new version of the experiment, mice were put in two different rectangular rooms. These rooms were identical to each other, except the north walls were decorated with vertical stripes in one and horizontal stripes in the other, and the food was hidden in different corners.

The mice made the same kind of geometry error as in the earlier study, equally searching in the correct corner and the one that was diagonally opposite it.

"Because the mice go to different sets of corners in different rooms," Epstein says, "we know they are using the stripes on the north wall to determine which room they are in. But despite the fact that the striped wall could also tell them which way they are facing, they don't use it for that. It's as if their internal compass was blind to the stripes, but their internal map could see it." ■





SOLAR-POWERED CLAMS

Tropical coral reefs may seem like idyllic environments, but organisms that live there have faced some extreme evolutionary pressures. The equatorial sun, for example, is so strong that plants can't make full use of its light without being damaged.

Natural selection has stumbled on a unique solution to this problem, with an unusual beneficiary: giant clams that “farm” photosynthesizing algae inside their bodies for food.

The light-bending proteins that enable this trick, as well as the clams' marvelous, iridescent color, are of particular interest to Alison Sweeney, assistant professor in the Department of Physics and Astronomy in the School of Arts & Sciences. A biologist by training, Sweeney investigates how evolution has produced biological structures that rival—and inspire—cutting-edge materials made in nanotechnology laboratories.

In the case of the giant clams, these structures, known as iridocytes, break up and scatter sunlight of different wavelengths, directing the most useful to the indwelling algae and reflecting the more harmful rays up and out. Because clams organize the algae into neat, crop-like rows, the iridocytes can deliver a precise dose of sunlight to the algae, boosting the efficiency of the whole system.

Sweeney describes this phenomenon in a study published in the *Journal of the Royal Society Interface* and supported by the Army Research Office and the Office of Naval Research. The research was co-authored by postdoc Amanda Holt and researchers from the University of California, Santa Barbara, Duke, and NASA's Ames Research Center.

The key to understanding the role these reflective structures play was revealing the internal geometry of clams' internal greenhouses. A layer of iridocytes is spread on top of pillars of algae suspended over the clam's stomach. Using laparoscopic cameras to simulate the position of individual algae, the researchers showed that the iridocytes spread blue and red light to the sides of the pillars.

“We see that, at any vertical position within the clam tissue, the light comes in at just about the highest rate at which these algae can make use of photons most efficiently,” Sweeney says. “The entire system is scaled so the algae absorb light exactly at the rate where they are happiest.”

These findings are now informing research on artificial iridocytes, which could boost the efficiency of bioreactors that grow algae as an alternative energy source. ■

Alison Sweeney investigates how evolution has produced biological structures that rival—and inspire—cutting-edge materials made in nanotechnology laboratories.



OVER THE PAST DECADE, ASTRONOMERS HAVE BECOME INCREASINGLY CONFIDENT THAT NEARLY EVERY STAR IN THE SKY IS AT LEAST ONE DISTANT PLANET'S SUN.

Thousands of these exoplanets have been detected, all with the hope that one might be Earth-like enough to harbor signs of life.

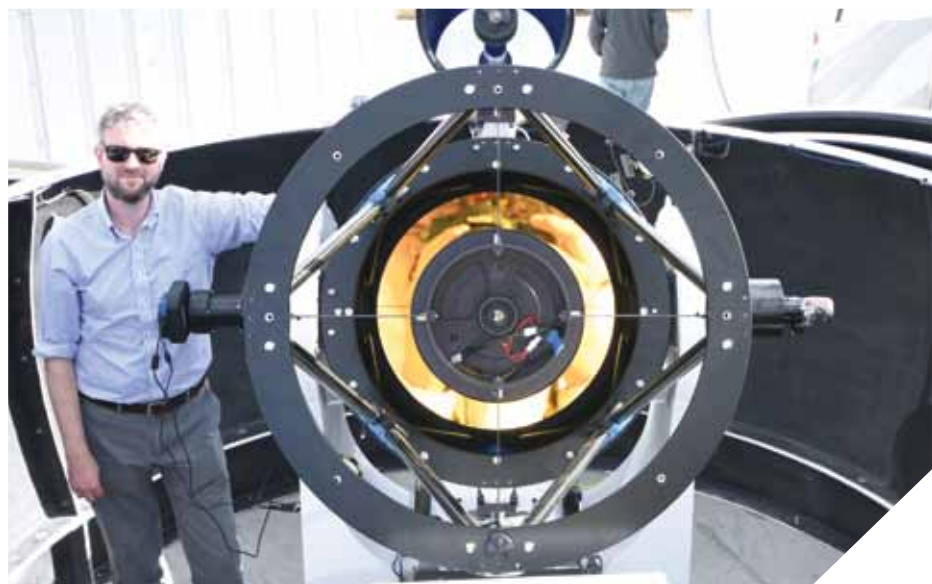
To maximize the number of sun-like stars they can see, most exoplanet hunters use space-based telescopes, free from atmospheric interference, or ground-based ones with massive, light-gathering mirrors. But Assistant Professor Cullen Blake and graduate student David Sliski of the Department of Physics & Astronomy in the School of Arts & Sciences are taking a different approach.

There are more than enough untapped targets in Earth's backyard, if one abandons the notion that an Earth-like planet must orbit a sun-like star.

Their telescope, MINERVA-Red, supported by NASA through a Nancy Grace Roman Technology Fellowship and installed last year at the Fred Lawrence Whipple Observatory in Arizona, is part of an international team of five small robotic planet hunters. As part of the MINERVA collaboration, Blake and Sliski will examine smaller, cooler stars, which emit mostly the infrared light that gives their telescope its name.

Though plentiful and nearby, cooler stars' dimness has historically limited astronomers' ability to detect and study their planets. However, a telescope specifically matched to the traits of those small stars has several advantages. It can be made from commercially available

Searching for Earth's Twin



components, costing more in the range of a luxury sports car than the half-a-billion dollar Kepler spacecraft, the most prolific planet hunter to date. And the planets surrounding such stars have closer orbits, a boon for the detection method that measures how a circling planet tugs on a host star.

Working within the larger ecosystem of planet hunters, telescopes like MINERVA-Red can help astronomers pick the best targets for future studies with larger telescopes, as well as follow up others' discoveries.

"There's going to be a ton of work for different telescopes to do, and small telescopes like MINERVA-Red will be able to make big contributions," Blake says. ■

ABOVE: Professor Cullen Blake with MINERVA-Red. Graduate student David Sliski, taking the photo, is visible in the telescope's mirror.

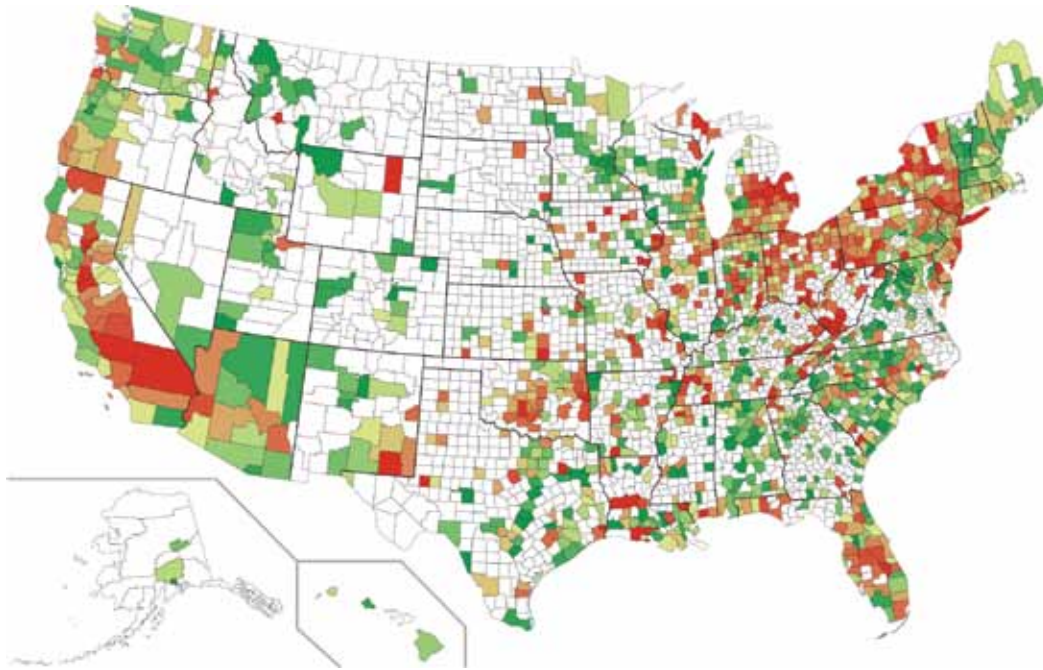
TOP LEFT (OPPOSITE): MINERVA-Red will look for planets around low-mass stars, light from which is mostly in the infrared part of the spectrum.

TOP RIGHT (OPPOSITE): Members of the MINERVA team, which includes researchers from Harvard, University of Montana, Penn State, University of New South Wales, Caltech, and University of Missouri.

BOTTOM (OPPOSITE): One of MINERVA-Red's advantages is that it's made of commercially available parts, lowering its construction and maintenance costs.

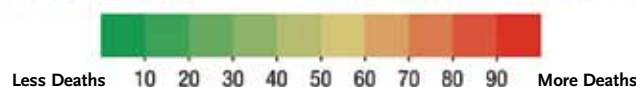
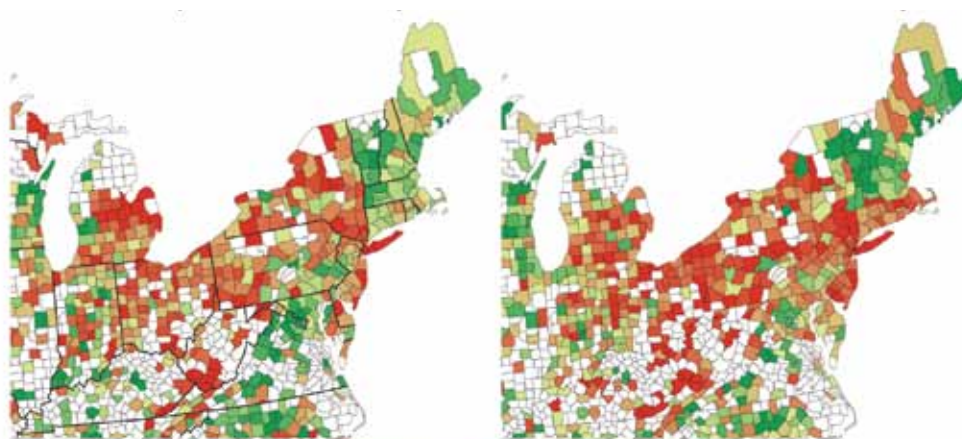


Which Communities Are At Risk For



TOP: The researchers compared county-by-county data on heart disease from the Centers for Disease Control and Prevention (pictured) with language in tweets.

BOTTOM: The map at left indicates heart disease rates as reported on death certificates, while the one at right shows heart disease rates as predicted by Twitter.



Twitter has helped bring cute animal pictures to millions and document social movements from the ground up.

The social media site can also be considered an accurate predictor of rates of atherosclerotic heart disease in communities across the United States.

In a paper published in *Psychological Science*, researchers at Penn have demonstrated that Twitter can capture more information about heart disease risk than many traditional factors combined, including levels of income and education, and rates of obesity, smoking, and hypertension.

Language in tweets expressing negative social relationships and emotions, disengagement, and expletives indicated a higher risk for heart disease, while positive emotions, optimism, and words associated with skilled occupations such as “management,” “learning,” and “conference” showed a protective association—in large part because they indicate high-income communities.

“We’re not capturing individuals who are dying from heart disease,” says Johannes Eichstaedt, a Ph.D. student in the Department of Psychology in the School of Arts & Sciences, and lead author on the paper. “We’re capturing the general psychological atmosphere in the communities where people are dying of heart disease. Twitter serves as a canary for a community.”

Researchers have previously thought that the well-being of communities is important for physical health, but this has proven difficult—and expensive—to study. Twitter solves that conundrum, Eichstaedt says, since tweets are

Heart Disease?

Look to Twitter



public, and samples are large. The researchers' data set consisted of public tweets between 2009 and 2010 from 1,347 U.S. counties, which house more than 88 percent of the country's population.

The team used three different approaches to analyze the language from the tweets, including an automatic process to measure the frequency of words and phrases, and compared these findings to data on heart disease deaths available from public health sources around the country.

Eichstaedt worked with H. Andrew Schwartz, a visiting assistant professor in the School of Engineering and Applied Science; Gregory Park, a postdoctoral fellow in the School of Arts & Science's Department of Psychology; Professor Martin Seligman, director of the Positive Psychology Center; Lyle Ungar, a professor of computer and information science; and Margaret Kern from the University of Melbourne, Australia.

The findings fit into existing sociological research that suggests that the combined characteristics of communities can be more predictive of physical health than the report of a single person.

"What Twitter is picking up on is that level of community context—how do people behave given stressors, how much anger there is in the community," says Eichstaedt.

"We're saying there are psychological statements to be made here, and this is a tool for psychology and sociology and for the human sciences, not just for the data sciences," he adds. "These disciplines make different kinds of claims than mere data science—they can help us understand the patterns by bringing the theory to the data." ■



Words associated with skilled occupations, positive experiences, and optimism showed a protective association against heart disease.

Ideas can spread like wildfire through social networks, be they online, at work, or the neighborhood gossip mill. A study by Penn's Damon Centola now shows that how a network is structured can either enhance or obstruct the spread of ideas.

Centola is an associate professor in the Annenberg School for Communication and the School of Engineering and Applied Science and director of the Network Dynamics Group. His work, supported by the James S. McDonnell Foundation, uses a computational model to revisit earlier research, which argued that societies where group affiliations were eliminated would be most conducive to the spread of shared knowledge and complex ideas.

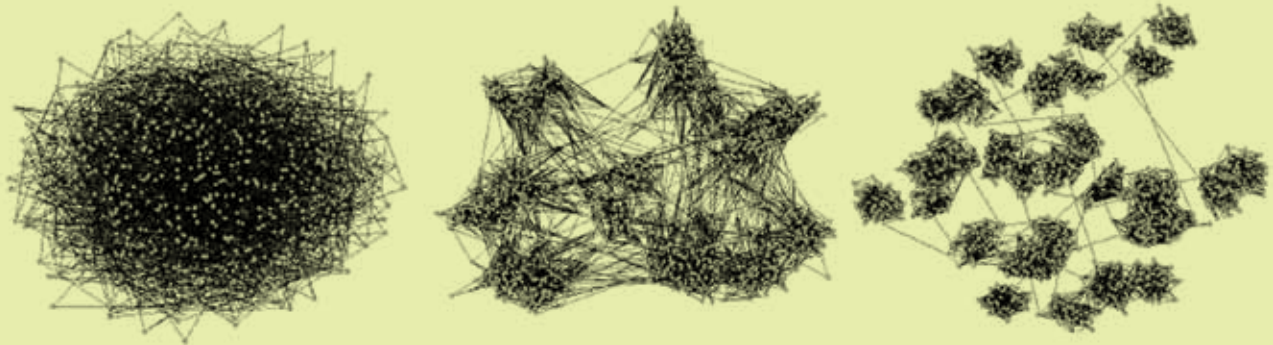
Centola's results have implications for how institutions encourage the spread of shared values and solutions to problems.

of complex ideas. Using computer models, he generated artificial "societies" in which characteristics like race, religion, income, and neighborhood defined individuals' identities. The degree to which people's characteristics correlated with one another determined their tendency to interact and thus the diversity of the social network.

If everyone with the same religion also had the same kind of job and lived in the same neighborhood, for example, then people would be unlikely to meaningfully interact with people of different religions.

The analysis revealed that the stronger the correlations between individuals' traits, the more "grouped" the entire network became. This, in turn, had an effect on how ideas could spread across the

How Ideas Spread Through Social Networks



“The spread of innovative ideas in society depends on diverse groups with overlapping memberships across them.”

In business settings, for example, the findings suggest that best practices and innovative ideas are more readily integrated across large organizations if strong ties within departments and work-groups are preserved.

Reporting in the *American Journal of Sociology*, Centola aimed to understand how social network formation influences the spread

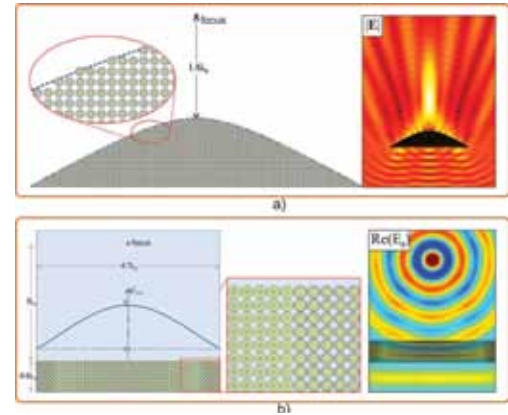
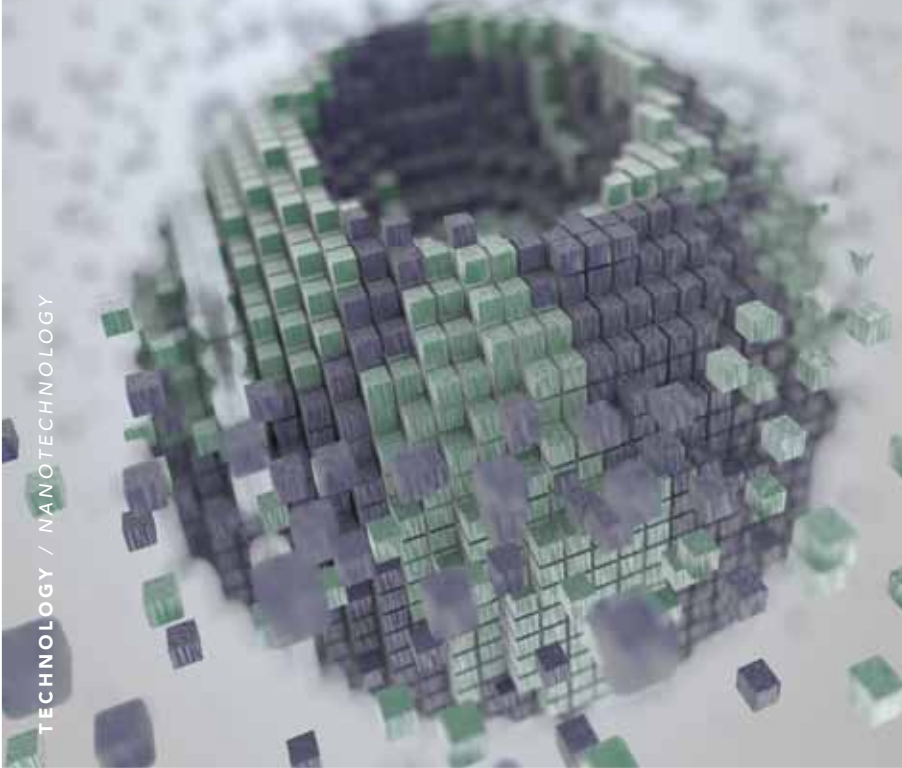
network. If a society was too grouped, ideas could not make the leap across social clusters to spread widely. But if groups were eliminated, people had little in common with others and thus little influence to spread complex ideas. The most successful societies were the ones in which people had strong network ties in multiple social groups, allowing complex ideas to rapidly spread across the entire population.

“There’s a belief that the more that people interact with strangers, the more that new ideas and beliefs will spread,” Centola says. “What this study shows is that the spread of innovative ideas in society depends on diverse groups with overlapping memberships across them.” ■

Networks that are moderately “grouped,” as in the center example, are the most conducive to spreading complex ideas.

INTRODUCING 'DIGITAL' METAMATERIALS

TECHNOLOGY / NANOTECHNOLOGY



TOP: A lens made out of identical metamaterial bytes (above) can be made flat by altering the composition of the bytes (below).

LEFT: An artist's conception showing the binary nature of digital metamaterials. It appeared on the cover of the December 2014 edition of *Nature Materials*.

The 21st century has been defined by the digital: the ability to take a piece of analog information and express it as a series of 1s and 0s.

Nader Engheta, the H. Nedwill Ramsey Professor of Electrical and Systems Engineering in Penn's School of Engineering and Applied Science, and postdoc Cristian Della Giovampaola are applying that concept to metamaterials—a cutting-edge field of nanotechnology that involves precisely designing composite materials that have electromagnetic properties not found in nature.

Metamaterials could be used to make light-bending invisibility cloaks, flat lenses, and other otherwise impossible devices, but figuring out the internal composition that results in these unusual effects is a challenge.

In a *Nature Materials* study, the Penn researchers present a way of simplifying things. They show that a metamaterial with a desired permittivity—the property of a material that describes its reaction to an electric field inside it—can be designed out of any two materials, so long as the permittivity of one is positive and the other is negative.

These components are the “bits” of “digital” metamaterials. They are combined into “bytes” that can take different shapes, such as nanoscale cylinders where one bit is wrapped in a shell of the other. By altering the radii and the order of the bits, the researchers mathematically demonstrated that a metamaterial with nearly any permittivity is achievable.

“If we wanted to make a lens with a permittivity of 4, but didn't have a single

material with that value, we could take any two materials with the positive/negative rule and design bytes such that they each have a permittivity of 4,” Engheta says. “If we arrange them together in the shape of the lens, the whole thing looks like it has a permittivity of 4 from the perspective of a light wave, even though none of the materials in it has that value.

“We can take it a step further, and make a flat lens that focuses light in the same way,” he says. “We could arrange bytes in layers, but instead of their height changing, we change their permittivity so that it bends the wave in a manner expected from the lens.”

The research was supported by the Office of Naval Research's Multidisciplinary University Research Initiative. ■

Liquid Crystals That Look Like Compound Eyes



MATERIALS SCIENCE

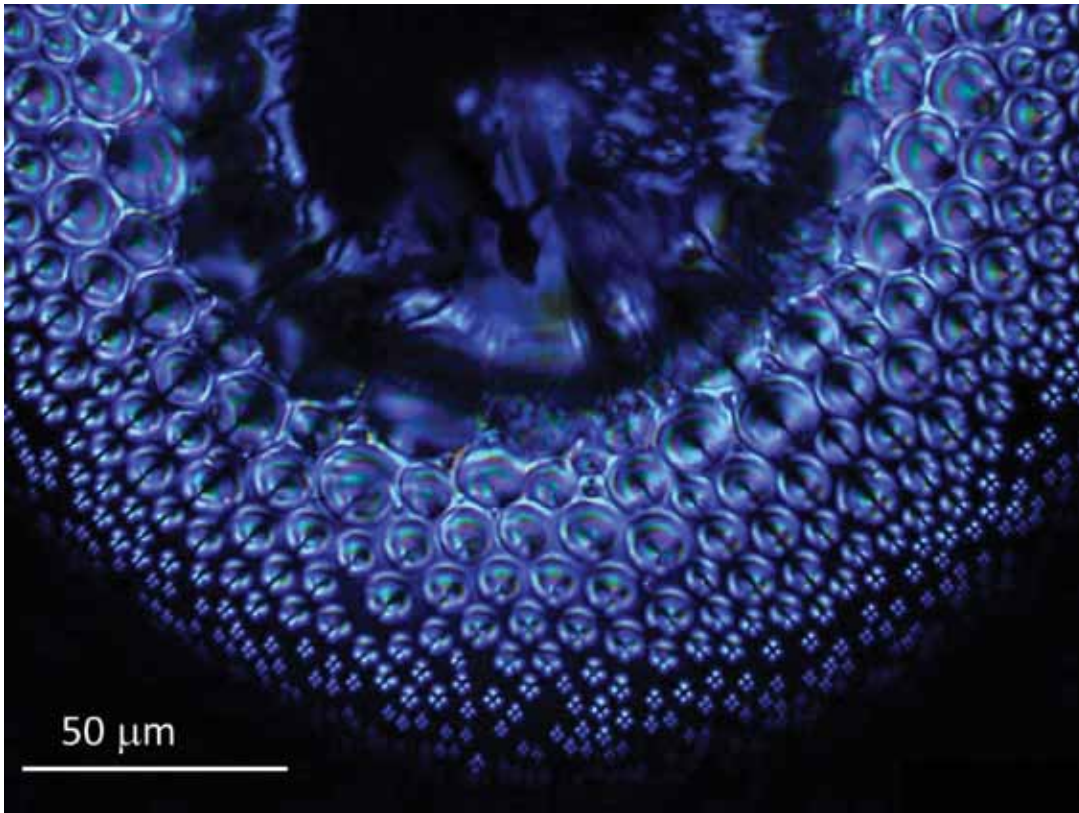
TECHNOLOGY

Compound eyes are marvels of evolution. In insects and some sea life, thousands of lenses work together to provide sophisticated information without the need for a sophisticated brain.

Penn researchers are showing how liquid crystals can be employed to create compound lenses similar to those found in nature.

Their study was led by Francesca Serra and Mohamed Amine Gharbi, postdoctoral researchers in the Department of Physics and Astronomy in the School of Arts & Sciences, along with Kathleen Stebe, deputy dean for research and a professor in the Department of Chemical and Biomolecular Engineering in the School of Engineering and Applied Science; Randall Kamien, a professor of physics; and Shu Yang, a professor in Penn Engineering's Department of Materials Science and Engineering. It was published in *Advanced Optical Materials* and supported by the National Science Foundation and the Simons Foundation.

Previous work by the group had shown how a certain class of liquid crystals naturally self-assembled into flower-like structures when placed around a central silica bead. Each "petal" of these flowers is a "focal conic domain," a structure that other researchers had shown could be used as a simple lens.



These compound lenses are the product of an ongoing research collaboration designed to direct the ability of liquid crystals to self-assemble into useful patterns. Previous work showed their tendency to arrange into focal conic domains surrounding a central bead or post. The researchers wondered if the fact that domains arrange themselves in descending size as they get farther from the post would give them optical properties like those found in natural compound lenses.

“Our first question,” Serra says, “was what kind of lens is this? Is it an array of individual microlenses, or does it essentially act as one big lens? Both types exist in nature.”

To tell the difference, the researchers put a test image between the lens and a microscope’s light source. They moved the microscope’s objective up and down until they could see an image form. Because the researchers saw multiple small images, instead of one large one, it was clear that each “petal” works like an independent lens.

The flower-like shape means that these microlenses get smaller as they get farther from the center. The differences in focal length this phenomenon produces allows for 3-D image reconstruction: Because the image

appears slightly different in each microlens, comparing those differences allows a viewer to interpret the depth of a scene.

A similar experiment showed how the array of lenses was sensitive to the polarization of light. Vertically polarized light showed the images on the left and right of the pillar, whereas horizontally polarized light showed images just on the top and bottom.

That these compound lenses self-assemble make them an attractive alternative to other artificial compound lenses, which require painstaking manufacturing techniques.

“If we ever wanted to mass-produce these lenses,” Stebe says, “we can use the same technique on arbitrarily large surfaces.” ■

IMPOLITE CONVERSATIONS AND HONEST LISTENING

Americans treasure their First Amendment free speech rights, but there are some topics that are not to be broached in public places or among mixed company. Unwritten societal rules say race and religion are off limits; sex, money, and politics, too. It would be considered impolite to do so.

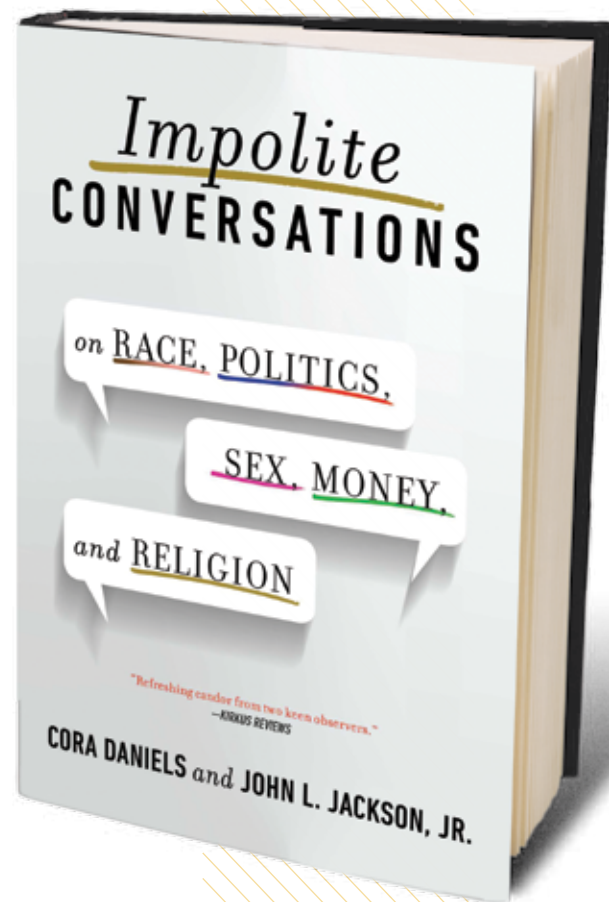
In “Impolite Conversations: On Race, Politics, Sex, Money, and Religion,” John L. Jackson, Jr., a Penn Integrates Knowledge professor and dean of the School of Social Policy & Practice, rips these unwritten rules to shreds in an unfiltered, uncensored conversation with journalist and co-author Cora Daniels.

Through friendly rivaling essays, Jackson and Daniels take on some of society’s most sensitive and controversial

“There’s almost a kind of seemingly hard-wired dysfunction in the language and rhetoric we use, especially for those issues we care about the most.”

issues concerning sex, money, religion, politics, and race, writing pieces that respond to one another.

“One of the things that drives this book is a concern with how unproductive our public discourse has become around important issues,” Jackson says. “I think we lament this fact at every turn. It impacts electoral politics, the way we think about and approach the most hot-button issues of the day. There’s almost a kind of seemingly hard-wired dysfunction in the language and rhetoric we use, especially for those issues we care about the most.”



Jackson and Daniels discuss the usually off-limit issues in ways that are less concerned with political correctness or towing a particular ideological line, and instead reflect an attempt to illustrate an “interpersonal honesty that tries to demonstrate a way to both speak and listen productively across political, and ideological, and social differences,” Jackson says.

They pull no punches. About sex, Daniels writes an essay, “Let’s pray for sexually active daughters” and Jackson replies with an article titled, “There’s a conspiracy to hyper-masculinize black boys.”

On religion, Jackson pens essays titled “Is Twitter the new religion?” and “Are black people still overchurched?” while Daniels asks, “Can a nation still have faith if it has lost its hope?”

Jackson’s essays on politics are titled, “I could be a Republican” and “Obama makes whites whiter.”

The book features nine essays on race—perhaps the hottest of hot-button issues. The section contains articles titled “Color Wars!” by Daniels, “All my best friends are light-skinned women” by Jackson, and an essay by each on the N-word, which is discussed in its raw, uncensored form.

Jackson says people are clamoring for what they imagine to be the authenticity of a kind of impoliteness.

“The idea is that sometimes one is polite in a way that’s interpreted as being disingenuous, as having ulterior motives,” he says. “But the issue isn’t the politeness *per se*, it’s that [politeness] is considered a kind of ruse or mask for some more dastardly beliefs and goals that might underpin people’s everyday actions.”

Jackson says he hopes the book serves as an example of what an honest conversation looks and sounds like, and helps to reestablish the lost art of honest listening. ■

Good Morning
Buenos días



The Dual Language Decree

For English language learners in the United States, research suggests that dual language education programs, which seek to systematically support students in developing academic skills in both English and their native language, are superior to English-only and transitional models that do little to develop their native languages.

In fact, it’s been found that dual language programs are the only programs to close the achievement gap between students who enter school as English language learners and those who enter as English-proficient. That’s why the School District of Philadelphia has been working to implement dual language education programs at six elementary schools, with guidance from Nelson Flores, an assistant professor in the Educational Linguistics Division of the Graduate School of Education.

Most of the schools used to operate what are known as transitional programs. Children who spoke Spanish were initially taught most of the day in Spanish. As they got older and became more fluent in English, lessons in Spanish faded away until students were only receiving English instruction.

Now all the schools involved offer programs where students are taught in both languages during their entire elementary school experience.

Flores’ primary role has been in supporting the district in developing the dual language programs in ways that are aligned with the latest research in the field.

“The structure of dual language programs has been questioned in recent years with a shift away from the idea that the languages should be strictly separated, toward the idea that the languages should strategically be brought together in ways that enhance learning,” Flores says. “Children perform better if they are allowed to move more freely between languages. As their comprehension improves in one language, it often improves in the other.”


It’s a major change for most of the teachers at the participating schools, including Southwark, which never had a bilingual program before, Cayuga Elementary Promise Academy, Elkin Elementary, Alexander K. McClure Elementary, and Bayard Taylor School, which had transitional bilingual education programs, and Luis Muñoz Marín, which, prior to this initiative, was the only district school with a dual language program.

Flores, who helps lead professional development workshops and garner teacher feedback, says the biggest challenge during the first year of the program, which officially got off the ground in the fall of 2014, was “fleshing out the nuts and bolts”: How do educators teach literacy in both Spanish and English, assess students in both languages, and effectively create schedules that follow this new process?

“It required quite a mind-shift in the teachers,” Flores says. ■

Using Wearables to Detect Gun Violence





Imagine a wearable technology that can accurately—and cheaply—detect when a community-based offender, such as someone on probation or parole, illegally shoots a firearm.

“We have a recurring problem of gun violence within the group of community-supervised individuals,” explains Charles Loeffler, the Jerry Lee Assistant Professor of Criminology in Penn’s School of Arts & Sciences. “We can know if you’ve taken an illegal narcotic in the last day, week, or month. That’s easy to do. But to try to gain similar information on whether someone has discharged a firearm, that is very hard.”

That is, at least, until now.

Loeffler tested the use of wearable sensors (similar to fitness trackers worn on people’s wrists) on 18 participants, including officers from the Penn Police Department, members of the general public, and construction workers. The construction workers performed their usual tasks, some of which included using pneumatic nail guns, pneumatic jack-hammers, .22 caliber powder-actuated fastener guns, and other demolition or building tools.

“In the case of those construction workers, the goal is to really get people who are engaged in activities that might

conceivably generate these sort of false-positive signals,” Loeffler says. “This is an application where we care intensely about accuracy. It is imperative that there are as few errors of any type as possible since it has the potential to have enormous consequences for people’s lives.”

The study, which was published in *PLOS ONE*, proved the technology could indeed detect firearm use from a variety of potentially confusable human activities, with a classification accuracy of 99.4 percent. It turns out that shooting a gun is a very peculiar activity when viewed from the perspective of the human wrist.

“We don’t do a lot of other things that generate signals on that time scale,” Loeffler explains.

He continues to refine the work that’s described in the paper, and determine whether there are related problems to be solved using a similar approach.

Loeffler’s research has the ability to transform the national system of corrections. But before any of that can happen, Loeffler says, the technology needs to be refined and ultimately commercialized. ■

It turns out that shooting a gun is a very peculiar activity when viewed from the perspective of the human wrist.



REAL ESTATE

SOCIAL SCIENCE



Food Deserts and Healthy Eating

According to the U.S. Department of Agriculture (USDA), 23.5 million Americans live in food deserts—areas without access to fresh, healthy, and affordable food.

Policymakers have attempted to eliminate food deserts by increasing the availability of healthy foods. Theoretically, providing individuals living in food deserts with healthier options will cause them to eat more nutritious foods. But according to Jessie Handbury, an assistant professor of real estate at the Wharton School, that isn't necessarily the case.

Handbury is the co-author of the working paper "Is the Focus on Food Deserts Fruitless? Retail Access and Food Purchases Across the Socioeconomic Spectrum" along with colleagues at Princeton University and the USDA's Economic Research Service.

Using six different datasets that collectively describe the nutritional quality of household food purchases, the stores located in the neighborhoods where these households reside, the nutritional quality of the products offered in these stores, and the demographics of these neighborhoods, the researchers found that even when controlling for access, disparities in healthy food consumption remain. Adding healthy food stores to food deserts produced little change in eating habits, particularly among low-income and less educated households.

Poor diets are often attributed to three factors: food deserts, preferences for unhealthy foods, and higher prices of healthy foods.

Handbury says public officials may have zeroed in on access because they can see immediate results.

"You can say, 'Look, here's a store that entered in this neighborhood that didn't have a store before,'" she says. "But, if the goal is for people to eat healthier foods, you may also need to take some steps to educate households on the benefits of the healthy foods available there."

The researchers report that improving access to retail outlets alone will do little to close the gap in the nutritional quality of diets across different socioeconomic groups, and more than 90 percent of the disparities across education levels would persist.

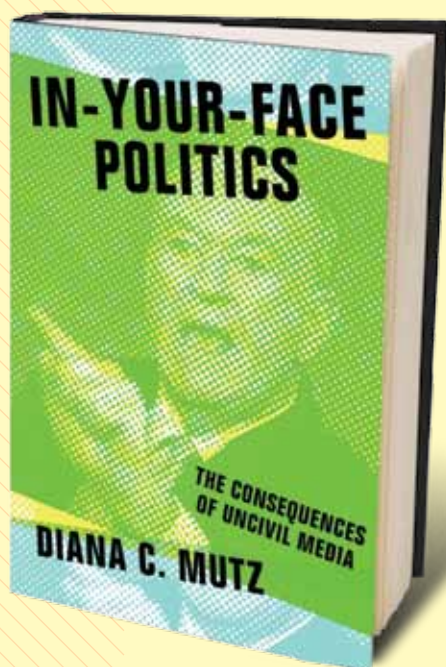
"The conclusion is that we think there needs to potentially be a more integrated approach of trying to tackle multiple factors at the same time, not just focusing on food deserts as being the root cause," Handbury says. "Because from what we've seen in this paper, they're not." ■

Civil Society Meets Uncivil Political Discourse

TURN ON ANY NUMBER OF TELEVISION POLITICAL PROGRAMS AND YOU’LL LIKELY SEE A PUNDIT RANTING AND RAGING. UP CLOSE. EXTREMELY CLOSE.

Since the late 1980s, there has been an increase in incivility on political television and in the use of extreme close-ups, bringing viewers into highly charged debates, almost as if they were occurring in their living room.

Just as people rubberneck on the highway to see automobile accidents, people have a hard time looking away from heated conflict.



Face-to-face arguments in the real world drive up a person’s level of physiological arousal and intensify a person’s emotional reaction to others.

In her book, “In-Your-Face Politics: The Consequences of Uncivil Media,” Diana C. Mutz, a professor of political science and communication in the School of Arts & Sciences and the Annenberg School for Communication, investigates how viewers respond to the increasing amount of incivility on television. She utilizes a series of laboratory and real-world experiments that look at how people react to uncivil debate and the appearance of close proximity to politicians as conveyed by television.

Mutz, who also serves as director of the Institute for the Study of Citizens and Politics, says the discourse on political television is far more heated than off-screen political conversations.

“Most people, when they talk about politics, are pretty civil with one another in day-to-day life,” she says.

But civil discourse does not make for exciting television. Just as people rubberneck on the highway to see automobile accidents, people have a hard time looking away from heated conflict.

Mutz says part of the increase in incivility is a consequence of competition. Producers attempt to make political shows livelier to compete with the vast number of channels, an approach that has both positive and negative aspects.

People are much more likely to discuss, remember, and share information from highly arousing, uncivil programs, thus expanding the spread of political information. However, these uncivil programs intensify negative reactions toward the opposition, and lower trust in politicians more generally. Mutz says that if people demonize the opposition, this can make the process of governing more difficult.

Mutz says her book demonstrates why political incivility is not easily dismissed as a disservice to democracy—and may even be necessary due to so much competition for the public’s attention.

“Fewer and fewer people watch any political programming because there are always other things on, and they’re very entertaining,” she says. “If we want mass [political] participation, then we need mass appeals. And that means making [political programming] exciting rather than dry and boring.” ■

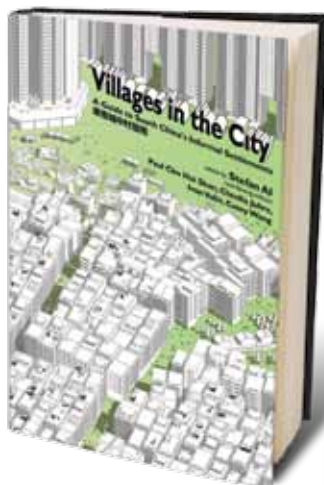
Indivisible Cities

Urban dwellers account for more than half of the world's population, and their numbers are multiplying.

However, cities can't construct buildings fast enough to accommodate the influx, and many of the urban newcomers don't have the means to access formal real-estate markets. As a result, most are moving into "informal settlements"—urban areas that evolve from the accretion of localized human activity without the benefit of formal planning and design.

With this worldwide trend comes an upsurge in related problems that range from discrimination, evictions, and violence, to dangerously insufficient municipal infrastructures. Two PennDesign faculty members have published books that bring their revelatory research to bear on this pressing global issue.

Stefan Al's "Villages in the City: A Guide to South China's Informal Settlements" and David Gouverneur's "Planning and Design for Future Informal Settlements: Shaping the Self-Constructed City" propose innovative, complementary solutions. Al, an associate professor of urban design, reveals ways to redevelop informal settlements sustainably and preserve their cultural heritage; Gouverneur, an associate professor of practice in the Landscape Architecture Department, outlines novel ways to assure the viability of their future.



The methodology and expertise Al and Gouverneur bring to the table fill substantial gaps in previous research on the topic.

For "Villages in the City," Al and his team spent eight months analyzing 18 informal settlements in South China. They documented the cultural heritage, population, and physical attributes of each one, revealing, he says, how the "fine-grain urban fabric" common to all of them "provides more intimate, human-scaled, and pedestrian-friendly urban spaces than many of the newly planned cities in China." Al hopes this vital new information will "help persuade city governments to integrate villages into, rather than expel them from, their cities."

Gouverneur's book is the fruit of 30 years' worth of experience-based research. Over this time, he adapted generic planning and design notions to specific sites throughout Latin America, compiling data that demonstrate "the limited impact traditional methods of planning and design have had on the informal city."

The book introduces a method called "Informal Armatures," which he says offers "a clear set of theoretical, practical, and pedagogical tools to merge the formal with the informal in ways that minimize urban disparities."

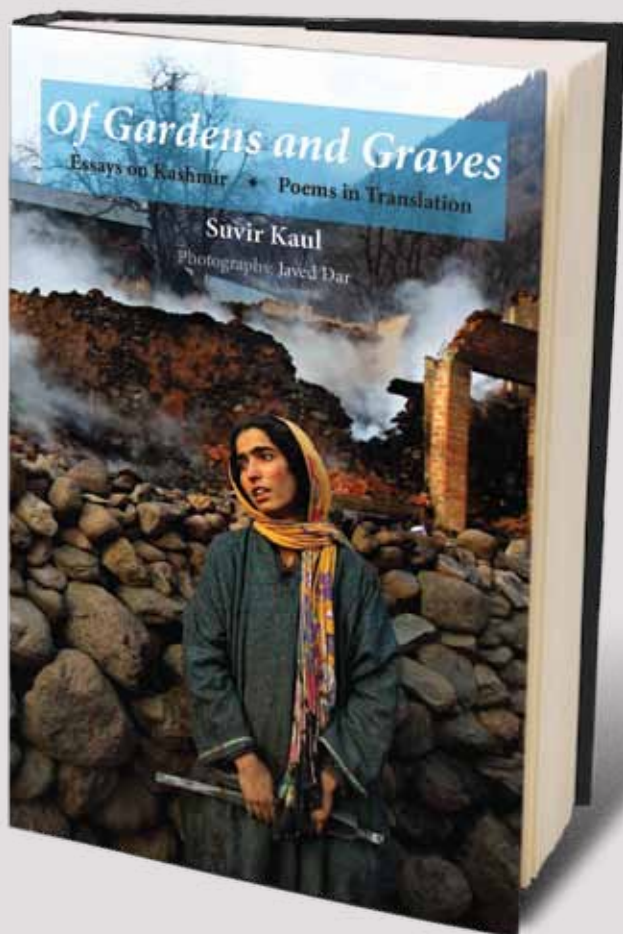
With informal settlements quickly becoming the dominant form of global population growth, their prosperity is a fulcrum upon which the future of cities, global health, and economic stability teeters. Al's and Gouverneur's research provides new paradigms necessary to secure a balanced urban environment for billions of people around the world whose subsistence depends on it. ■

ESSAYS & DISPUTED

For nearly 70 years, since the partition of India in 1947, the disputed area of Kashmir has been caught in a tug-of-war between India to the east and Pakistan to the west, including near-nuclear standoffs in 1999 and 2002. Both countries claim the territory as their own.

Lost in the conflict has been the self-determination of Kashmiris themselves.

In 1989, an armed rebellion by Kashmiris erupted in the Indian-controlled section of Kashmir. What followed, says Suvir Kaul, a professor of English in the School of Arts & Sciences, was a decade of intense violence in Kashmir between Kashmiri rebels and the Indian government.



POEMS FROM KASHMIR

Kaul's book, "Of Gardens and Graves: Essays on Kashmir, Poems in Translation," examines everyday life in Kashmir after 1990 through contemporary essays, poems, and photographs.

Due to political circumstances, many Hindus left Kashmir—which is primarily Muslim—in the 1990s. Kaul's family also stayed away during this period, but in 2003, after the Indian army had largely defeated the rebellion, they returned home.

While the violence had subsided and the presence of the security establishment declined, Kaul says it had by no means disappeared.

"It was extremely intrusive and most Kashmiris lived in circumstances of

everyday—I don't want to use the word terror, but something just short of that," he says. "The fear of surveillance, the fear of being stopped on the street, the fear of being asked questions was a daily feature of everybody's life."

"Of Gardens and Graves" is based on essays written by Kaul over the last decade in his effort to come to terms with what he saw and felt during his yearly visits to Kashmir. It contains personal essays written by Kaul, poems by Kashmiri writers, and photographs by photojournalist Javed Dar.

"A couple of the essays are really my account of how I had to relearn my own understanding of the relations between

Kashmir and India," Kaul says.

The poems in the book were translated from Kashmiri to English by Kaul and a group of collaborators.

"Out of the many hundreds of poems that I looked at and translated, this contains 28 poems that are about conflict, about the nature of life and experience in a conflict zone," says Kaul.

Kaul says he chose Dar's photos not because of their journalistic aspect, but because of their compelling quality.

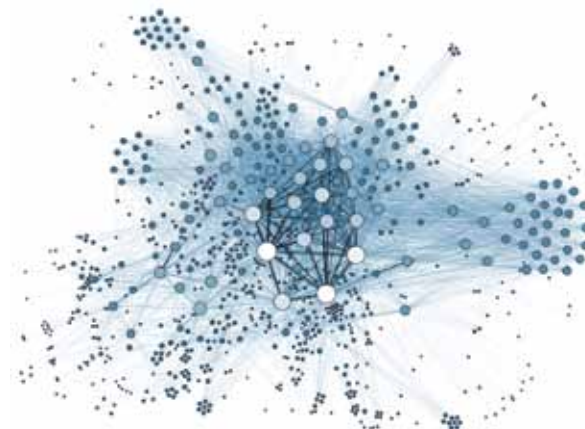
"They make the case for what has been happening in Kashmir very eloquently," he says. ■

A DIGITAL ALLIANCE

An erroneous dualism between the sciences and humanities has long loomed over academic research. Several recent University advancements have demonstrated that, at Penn, the individualist, book-driven methods that once limited humanities researchers have now been augmented by the collaborative, technology-driven methods usually associated with scientific research.

School of Arts & Sciences Dean Steven Fluharty unveiled the Humanities in the Digital Age initiative as a key component in the School's new strategic plan. The state-of-the-art Price Lab for the Digital Humanities is slated to open in the spring of 2016, along with a profusion of programs set to expand the abilities of humanities researchers to access the tools—and harness the power—of technology.

According to James English, professor of English and faculty director of the Price Lab, these resources will enable science and humanities researchers alike to reconsider the differences that once divided their methodologies and to develop ambitious new lines of interdisciplinary scholarship. ■



Lacking Rights at Work

Contrary to popular belief, most Americans lack constitutional rights on the job. That means, for example, the First Amendment wouldn't protect a worker from being fired for attending a gay rights or anti-abortion rally on his or her own time. With a few exceptions, most workers can be fired for almost any reason, or no reason at all.

It's something that has sparked Sophia Lee's interest since she researched *Brown v. Board of Education* for a professor at Yale University more than a decade ago.

"I was reading all of this material from the middle of the 20th century, and there were all these different areas where they were trying to tackle racial discrimination, but there didn't seem to be any efforts to tackle racial discrimination in the workplace," says Lee, now a professor of law and history at Penn Law School.

Work is such an important part of life, she thought, so why hadn't these challenges been awakened?

The more Lee dug, the more she found that there actually were a lot of these challenges in the workplace, but "for a number of reasons they weren't obvious to me at first or to anyone who had been writing about this period in the past."

Cue lesson No. 1 for Lee, who explains that in order to understand constitutional history, historians need to look

"not just at courts and people who were bringing their claims in courts, but really look at administrative agencies and what's happening there."

Once Lee knew where to look, her research laid the groundwork for several graduate papers and articles. Her work evolved into her dissertation, which she finished during her second year working at Penn.

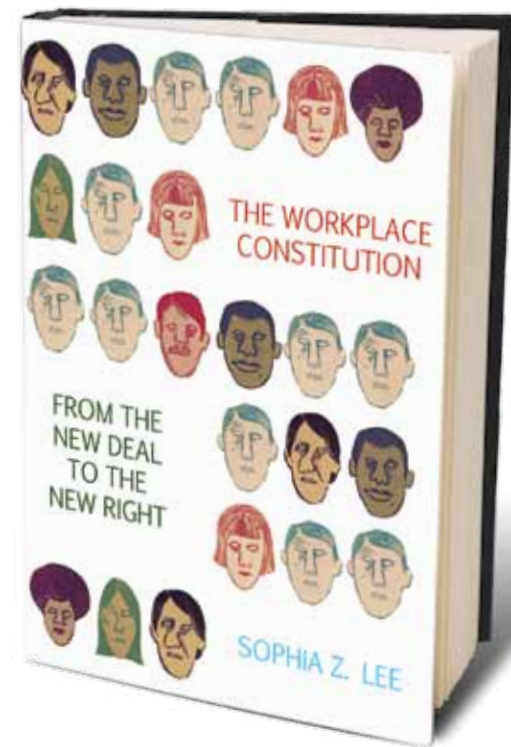
Lee spent years traveling all over the country gathering information about the history of fighting for constitutional rights in the workplace, and its ultimate failure.

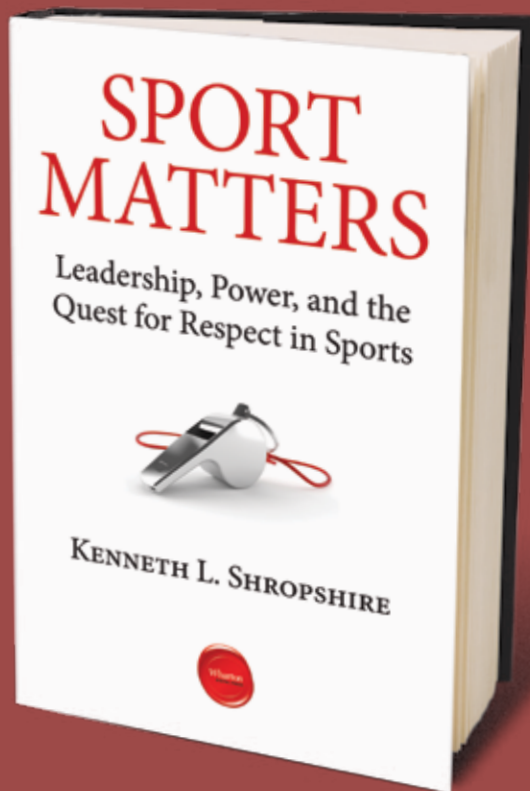
Lee's dissertation unfolded into her first book, "The Workplace Constitution: From the New Deal to the New Right," which was published by Cambridge University Press.

For a general reader, there are several aspects of Lee's book that speak to contemporary issues. For one, it examines the legal and political history of the right-to-work movement, something Lee describes as "a very hot issue today."

It also dives into how American workers evolved throughout the years.

"If you're interested in the status of workers today and particularly the precariousness of workers today, I think the history is really important in terms of thinking about what we can learn from the past and what might be a path forward," Lee says. ■





BUSINESS / ETHICS

LEADERSHIP, POWER, AND RESPECT IN SPORTS

Kenneth L. Shropshire, a professor of legal studies and business ethics at the Wharton School and director of the Wharton Sports Business Initiative, was planning to write an update of a book he had previously penned about race and sports in America when the sports world was engulfed by a series of controversies: The NFL/Ray Rice domestic violence scandal, alleged bullying on the Miami Dolphins, college athletes challenging their status as amateurs, the debate regarding the Washington Redskins' team name, and the drama between the NBA and former Clippers owner Donald Sterling.

Shropshire has consulted for years with the NFL, MLB, the NCAA, and other top sports organizations, owners, executives, and athletes on issues related to diversity, inclusion, equality, and respect. In his book, "Sport Matters: Leadership, Power, and the Quest for Respect in Sports," published by Wharton Digital Press, he focuses on the unique leadership challenge to embrace and deliver these principles in a real and tangible way within the sports industry.

The book is intended to be a snapshot of where America stands in its societal journey by focusing on key sports power issues. It also seeks to provide business and other leadership lessons, and the

outline of a framework that can be applied beyond the world of sports.

Shropshire says the ease of information has brought issues of equality and respect in sports to the public's attention like never before.

"We probably wouldn't have even known about the Dolphins incident had it not been for Twitter and text messaging," he says.

Shropshire spoke with his contacts in the sports world for the book and says he was surprised that so many have not thought about diversity in terms other than numbers. He says diversity without inclusion is hollow; statistics alone are not enough.

"It's not just diversity, it's inclusion, it's respect and equality," he says. "That's something I thought was certainly interesting. It wasn't something that leadership in sports, or in other industries for that matter, fully focused on. The numbers yes, the inclusion no."

Shropshire says he hopes the book has an impact in sports and beyond, and causes individuals to think more about diversity, inclusion, respect, and equality "across the board in whatever activities, whatever businesses they're involved in.

"At a minimum, what we're looking for is respect," he says. "Not just to tolerate someone who's different or believes differently, but really to respect them and provide the same opportunities for anybody, no matter who they are." ■

"It's not just diversity, it's inclusion, it's respect and equality."



Bragging Can Pay Off— Sometimes

An investment banker and social worker separately post on social media about their weekend spent volunteering with a local nonprofit organization. One is thought by their peers to be a generous person. The other is perceived negatively.

Why does bragging benefit some but not others?

The key is new information, says Deborah Small, a professor of marketing and psychology at the Wharton School.

“Bragging only pays off and only positively affects your reputation as a generous person if people are otherwise unaware of your goodness,” Small explains. “Bragging has a positive effect by providing information, and a negative effect by signaling a selfish motive. And if you already have the information, then that positive effect goes away and you only get the negative effect.”

This means the investment banker—who works in an industry that is stereotypically perceived as being a selfish one—benefits more from bragging than the social worker because the banker is providing new information when they mention volunteering. Conversely, the social worker, who has a more generous reputation, may actually be harmed: Bragging about volunteering only signals to others that his or her motives are not pure.

Small worked with Wharton doctoral candidates Jonathan Z. Berman, Emma E. Levine, and Alixandra Barasch on this and six other studies about bragging and perceptions of altruism for her recent paper, “The Braggart’s Dilemma: On the Social Rewards and Penalties of Advertising Prosocial Behavior,” published in the *Journal of Marketing Research*.

They also found that so-called altruistic purchases—those meant to overtly signal one’s generosity—must be inconspicuous in order for others to perceive the buyer as generous. The content of a message can also influence how others see a person: People who brag about a commitment to a nonprofit and then urge others to donate are seen as more altruistic than those who simply talk about their good deeds.

Small, who is currently measuring the effectiveness of incentives given to advocates for a cause, says it is the case that people always like you less when you brag. Nevertheless, it still can pay to brag.

“People get credit for doing good, but only if others find out about it and bragging is one way to get the word out,” Small says. ■

**Why does
bragging
benefit
some but
not others?**

Drinking Alcohol

CONTINUED FROM PAGE 4

Holmes says. “We had sufficient data to show alcohol is harmful no matter how much you consume.”

Holmes examined the health of people with a variant of the “alcohol dehydrogenase 1B” gene, which breaks down alcohol at a quick pace, and certain genetic variants that have been found to lead to lower levels of consumption over time. The team used this genetic marker as an indicator of lower alcohol consumption and identified links between these people and improved cardiovascular health.

Holmes says despite the logistical challenge of ensuring they combed through similar data sets from the 50 studies, the results have broad implications for anyone who drinks—and especially for those who imbibe because of the supposed heart-saving effects.

“If you can reduce the amount of alcohol you can drink, then reduce it,” Holmes says. ■

Treating a Rare Disease in Cats, Then Kids

CONTINUED FROM PAGE 7

foundations, and private donations from families of affected children.

NPC, which arises from a genetic mutation, interferes with how cells process cholesterol. While details of the underlying pathology remain somewhat mysterious, the research team knew a compound called cyclodextrin could remove cholesterol from cells.

Based on earlier work in mice, the team administered cyclodextrin to cats subcutaneously. When that caused lung problems, they decided to infuse the compound directly into the fluid surrounding the brain, starting when the cats were 3 weeks old.

“Cats with NPC that aren’t treated die at 6 months of age, but the cats who were treated looked normal at 6 months of age,” Vite says. “It was astonishing.”

Some of the cats treated with the highest dose have survived past three years of age and have gone on to have kittens.

Vite and colleagues are continuing their work to find other effective treatments and better understand the underlying causes of the disease.

“It doesn’t get any better than finding something that treats animals and then will go on to treat kids,” Vite says. “That’s the holy grail. That’s what keeps us going.” ■

Q&A with Danielle Bassett

CONTINUED FROM PAGE 9

who reconfigured their brain more were able to learn much better than people who reconfigured their brain less.

We also find that there are very specific pieces of the brain that get disconnected as people get better at this task. The parts that get disconnected are known as cognitive control hubs, and when they get disconnected, people learn better. These are parts of the brain that are involved in very difficult decision-making, so it suggests that relaxing and not trying so hard is actually helpful for extended learning.

What new initiatives does the MacArthur Award help fund?

MacArthur is supporting a combined internship and outreach program we founded that involves visualizing network science. We have a class of art interns who come here for the summer; they work one-on-one with faculty members for a week. Then they go and create artistic pieces, interpreting and conceptualizing cutting-edge research at Penn that broadly deals with network science.

At the culmination of the program, we have a gallery-style event to display the pieces that they have created to our local Philadelphia community. We also use these pieces in our art and science classroom, an event that has drawn middle and high school students from many schools in the Philadelphia area.

We are currently working with the Netter Center [for Community Partnerships] to take those pieces on the road in outreach events, to talk about overlaps between art and science, especially as they pertain to networks.

How does art inform your own work?

Network science is a very difficult field; the data are very complicated and you are trying to embrace that complexity rather than reduce it down to little pieces. The very best way to understand the actual organization of these networks is often through visualization.

Visualizations, and particularly artistic visualizations, are critical to network science. Many people in network science fields think that a very good visualization is 90 percent of your way to writing a paper; that’s actually how you discover structure. Without that discovery, there’s no science. ■



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