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IMPACT

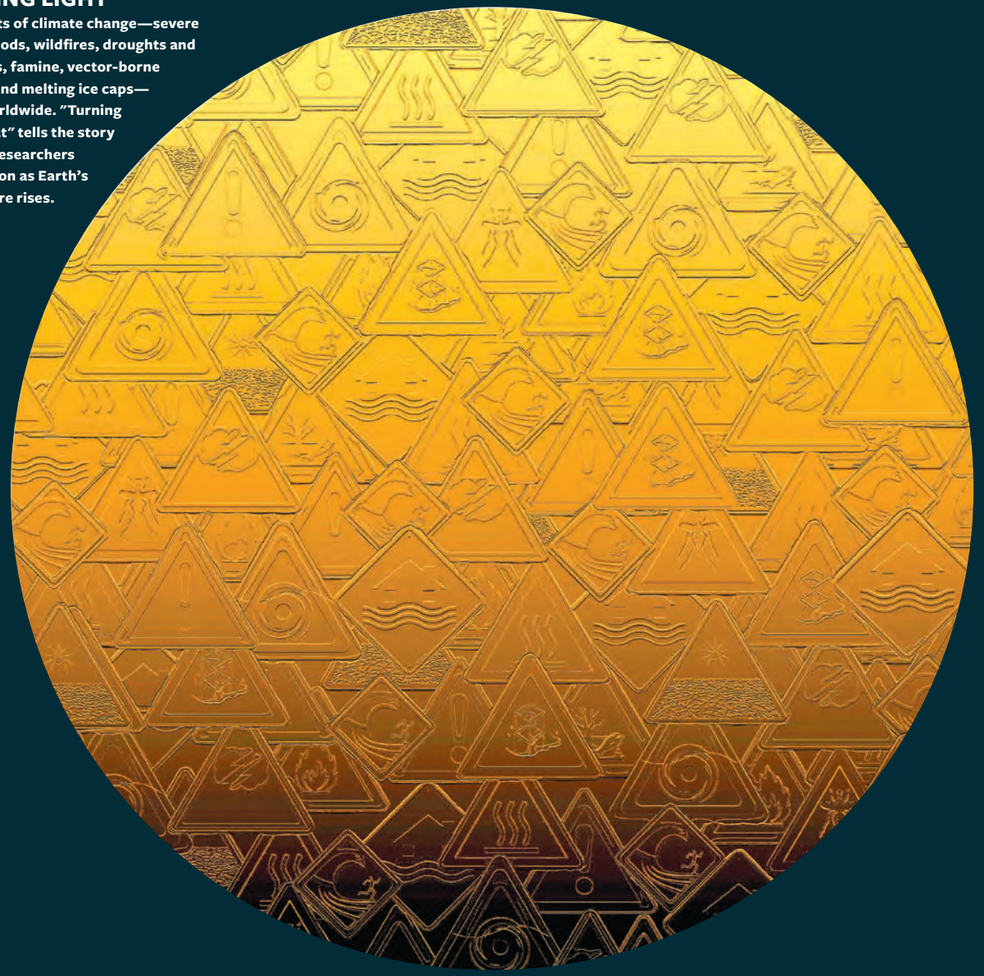
RESEARCH AT BROWN 2022

UNDAUNTED
Student Research
Despite COVID-19

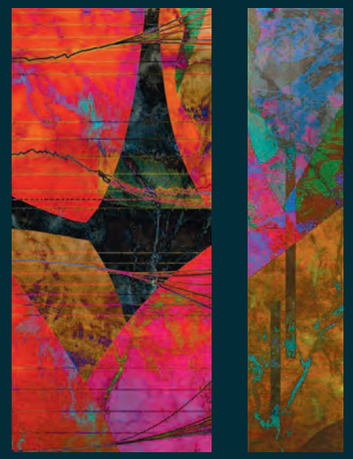
TEACHABLE MOMENT
A New Dean's Vision
for the School of Public Health

TURNING UP THE HEAT
on Climate Change Solutions

WARNING LIGHT
The impacts of climate change—severe storms, floods, wildfires, droughts and heat waves, famine, vector-borne diseases, and melting ice caps—are felt worldwide. "Turning Up the Heat" tells the story of Brown researchers taking action as Earth's temperature rises.



THE ART



ON THE COVER: Our search for a cover image led to Alisa Singer's Environmental Graphiti® online gallery after seeing her work on the striking cover of *Climate Change 2021: The Physical Science Basis*, on the Intergovernmental Panel on Climate Change (IPCC) website. By chance, one of the paintings in her gallery was connected to Professor Baylor Fox-Kemper, a lead coordinating author for the chapter on ocean, cryosphere, and sea level change in *The Physical Science Basis* (see page 23). He had worked on Figure SPM.8 in the IPCC Summary for Policymakers and, separately, Singer had rendered the same figure into a vivid painting to illustrate the alarming data shown in the graphs. This painting is our cover image.

https://www.environmentalgraphiti.org/all-series/ocean-acidification-threatens-marine-life-yp9zw

COVER IMAGES: FRONT—MULTIPLE IMPACTS TO OCEANS AND ICE SHEETS FROM GLOBAL WARMING ©2021 ALISA SINGER. BACK—WARNING - THE MANY PLAGUES OF CLIMATE CHANGE ©2021 ALISA SINGER. WWW.ENVIRONMENTALGRAPHITI.ORG

THE SCIENCE

MULTIPLE IMPACTS TO OCEANS AND ICE SHEETS FROM GLOBAL WARMING

Human activities affect all the major climate system components, with some responding over decades and others over centuries.

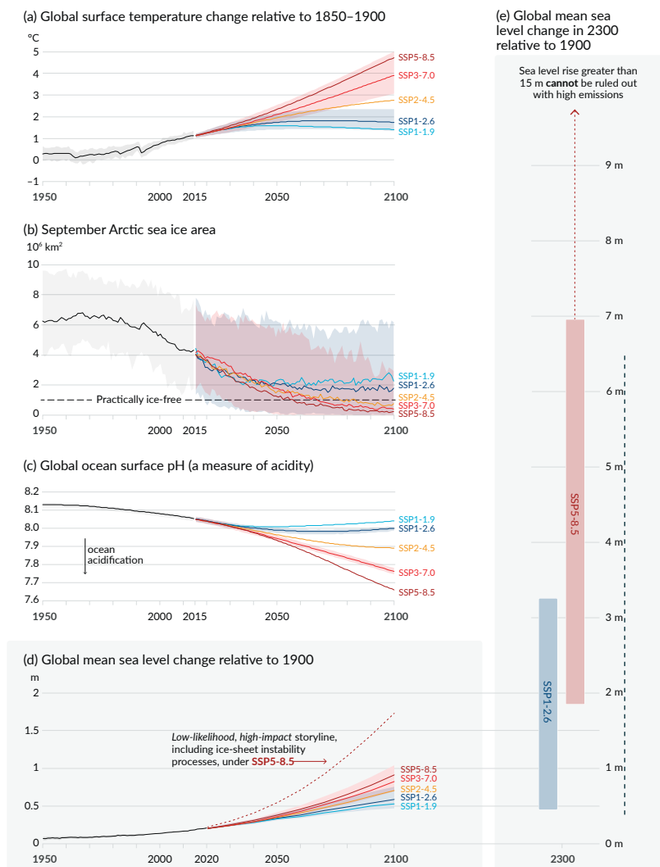


FIGURE SPM.8 | SELECTED INDICATORS OF GLOBAL CLIMATE CHANGE UNDER THE FIVE ILLUSTRATIVE SCENARIOS USED IN THE WORKING GROUP I SIXTH ASSESSMENT REPORT

The projections for each of the five scenarios are shown in color. Shades represent uncertainty ranges. The black curves represent the historical simulations (panels a, b, c) or the observations (panel d). Historical values are included in all graphs to provide context for the projected future changes.

Emissions Scenarios
SSP5-8.5—Very high greenhouse gas (GHG) emissions
SSP3-7.0—High GHG emissions
SSP2-4.5—Intermediate GHG emissions
SSP1-2.6—Low GHG emissions
SSP1-1.9—Very low GHG emissions

"SPM.8 shows key indicators of climate change in the atmosphere, ocean, and cryosphere (i.e., frozen parts of earth). Surface temperatures (panel a), Arctic sea ice during September (panel b; the month with the least ice), and surface ocean pH (panel c; a marker of ocean uptake of carbon dioxide, which acidifies the oceans) respond rapidly to accumulating atmospheric carbon dioxide.

Sea level (panel d), on the other hand, responds more slowly as the deep ocean and distant ice sheets catch up to past levels of warming. Thus, sea level rise by year 2050 is almost independent of emissions reductions, while year 2100 shows a spread. By year 2300 (panel e), the sea level rise is over five times higher, centuries after emissions have reached net zero. A dashed line shows the potential changes to sea level from the ice sheets that cannot be ruled out under high emissions, bringing large rises sooner than expected."

— BAYLOR FOX-KEMPER, PROFESSOR OF EARTH, ENVIRONMENTAL, AND PLANETARY SCIENCES

Panel (a) Global surface temperature changes in °C relative to 1850–1900. These changes were obtained by combining Coupled Model Intercomparison Project Phase 6 (CMIP6) model simulations with observational constraints based on past simulated warming, as well as an updated assessment of equilibrium climate sensitivity. **Panel (b) September Arctic sea ice area** in km² based on CMIP6 model simulations. The Arctic is projected to be practically ice-free near mid-century under intermediate and high GHG emissions scenarios. **Panel (c) Global ocean surface pH** (a measure of acidity) based on CMIP6 model simulations. **Panel (d) Global mean sea level change** in meters, relative to 1900. The historical changes are observed (from tide gauges before 1992 and altimeters afterwards), and the future changes are assessed consistently with observational constraints based on emulation of CMIP, ice-sheet, and glacier models. The dashed curve indicates the potential impact of deeply uncertain processes. **Panel (e) Global mean sea level change at 2300** in metres relative to 1900. The dashed arrow illustrates low-likelihood, high-impact ice-sheet processes that cannot be ruled out.

IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. Figure SPM.8, Page 22.

IMPACT
RESEARCH AT BROWN 2022

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STARTING OFF

IMPACT: RESEARCH AT BROWN is a retrospective of research highlights from the preceding year. The stories capture the breadth of research across Brown University as well as the context of our current times. This past year presented an extended COVID-19 public health crisis; a commitment to train the next generation of researchers despite the pandemic; and, above all, a heightened awareness of our global responsibility to address climate change, based on unprecedented weather events and new data about warming temperatures worldwide.

The feature stories in this fifth issue of *Impact* take on these themes. See how Brown is accelerating its research to find climate change solutions in the cover story, "Turning Up the Heat." For years, climate-related research has been underway within multiple areas of the University—at the Institute at Brown for Environment and Society; the Watson Institute for International and Public Affairs; and the departments of physics, engineering, and earth, environmental, and planetary sciences. Now major new projects are deepening and focusing these efforts.

Remote research has taken on a different meaning during the past two years, given the disruptions to campus and field research due to the pandemic. Students have shown remarkable ingenuity and flexibility in carrying out their research projects independently. In "Undaunted," you'll meet six ambitious students who found unexpected opportunity in this new normal.

"Teachable Moment" looks at the role of public health as the country continues to grapple with the pandemic. Ashish Jha's appointment as dean of Brown's School of Public Health has been transformative for both Jha and the School. In an interview given after his State of the School address in September 2021, he talks about how public health research is growing at the University, springboarding from the needs and challenges revealed by the pandemic, and offers a preview of new initiatives that will position the School as a leader in public health. In April 2022, Jha begins leading the nation's pandemic response, appointed by U.S. President Joe Biden to a short-term special assignment as the White House coronavirus response coordinator.

Like Jha, Brown researchers are often at the leading edge of their fields. George Karniadakis is developing a new Artificial Intelligence (AI) technique to help doctors predict aneurysm ruptures through physics-informed neural networks that assess blood pressure. Julie Strandberg, who started the dance program at Brown 50 years ago, designed and implemented research-based programs in the performing arts for people with Parkinson's disease and those with autism spectrum disorder. Lorin Crawford, Brown's first Packard Fellow and one of *Forbes*'s 30 Under 30 in science, develops deep learning algorithms to study the interactions between genes that contribute to diseases. The first-ever Brown artistic director Avery Willis Hoffman discusses the evolution of arts exploration at Brown in an interview with *Impact*. And Pulitzer Prize-winning David Kertzer, one of the leading historians of the Vatican, was one of the first researchers to gain access to the newly unsealed archives of Pope Pius XII.

We hope you'll be inspired by these and other stories that demonstrate how research at Brown continues to make a positive impact in the world.

Jill Pipher
Vice President for Research
Elisha Benjamin Andrews Professor of Mathematics

KINDRA CLINEFF

ILLUSTRATION BY YIXUAN WANG '18

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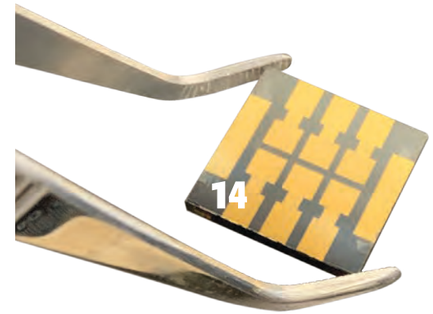

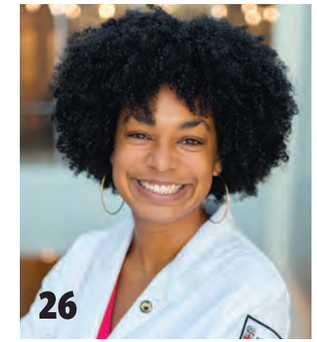

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RESEARCH BRIEFS

A COMPENDIUM OF RECENT HIGHLIGHTS OF BROWN RESEARCH

MIKE COHEA/BROWN UNIVERSITY; DEIRDRE CONFAR

Top view of Brown University's Slavery Memorial stone plinth, sculpted by Martin Puryear.

Renée Ater, visiting associate professor of Africana studies, at Brown's Slavery Memorial site on the Front Green.

Slavery and Racism in Monuments, Examined

Pathbreaking research on race, public art, and national identity informs online repository of American memorials.

WHY DO COMMUNITIES build monuments and memorials? What do these structures celebrate? And whom do they exclude?

In 2020, in the midst of a reckoning with systemic racism in the United States following the death of George Floyd, these questions came up again and again in cities and towns across the country. But for **RENÉE ATER**, a visiting associate professor of Africana studies at Brown, questions such as these were nothing new.

"Our monuments show that, for centuries, we've mostly wanted to celebrate men who have done great things but also heinous things," Ater said. "By memorializing that select group, we've essentially said that we believe their stories are the national story. It's been fascinating watching millions of people beginning to recognize how exclusionary that is."

A decade ago, Ater began investigating how cities and towns across the U.S. were grappling with their historical ties to slavery. Over several years, she built Contemporary Monuments to the Slave Past, an online repository of more than 100 American monuments and memorials that address slavery and racism, including Brown's own Slavery Memorial.

Ater's expertise has thrust her into the center of the national discussion about how public monuments do and don't address slavery, colonialism, war, and white supremacy.

Throughout the 2021–2022 academic year, she's lending her knowledge to Brown courses on memorialization and race, event and project partnerships with the Center for the Study of Slavery and Justice and other campus entities, and a joint project with the University library that will transform her online repository into an interactive, born-digital publication.

"People always say, 'I don't really pay attention to monuments,'" Ater said. "But whether or not we're totally consciously processing it, these monuments are sending us messages about what's important and what's worth remembering." —JILL KIMBALL

VISIT WWW.SLAVERYMONUMENTS.ORG

Romy Frömer, postdoctoral research associate (left), and Amitai Shenhav, assistant professor of cognitive, linguistic, and psychological sciences, study the neural activity of decision making.

Why Even Try?

Brain science research helps answer one of life's biggest questions.

WHAT MAKES SOMEONE DECIDE TO TRY? A study by Brown researchers shows that the amount of mental effort invested in a task is influenced not just by what a person stands to gain but also the degree to which that outcome will depend on their performance.

"For example, when applying to college or a new job, there are many factors that might affect success, and only some of them are within an applicant's control," said **ROMY FRÖMER**, a postdoctoral research associate in **AMITAI SHENHAV**'s lab at Brown's Carney Institute for Brain Science and a lead author on the study. "When faced with all of these variables, we wondered: how do people decide the amount of effort to invest?"

Previous research has shown that people often expend more effort on a task when it promises greater rewards. However, if the person thinks they'll succeed or fail regardless of their efforts, they may decide not to invest the effort. The research team put this theory to the test by having participants perform a series of trials of a psychological experiment that involves looking at words shown in different colors of ink and naming the color of the ink even when it doesn't match with the word (for example, the word *red* printed in green).

The researchers varied the difficulty and the expectations of efficacy and reward. The trials were meant to emulate real-world decisions: while it's sometimes easy to draw a line between how much work you put in and how much reward you'll accrue (as with a quiz), there are many situations in which this association is less direct.

The researchers demonstrated that participants performed better on tasks when there was a bigger potential prize *and* when they felt like their efforts made a difference in earning that prize. The study also identified the neural activity associated with the decision process.

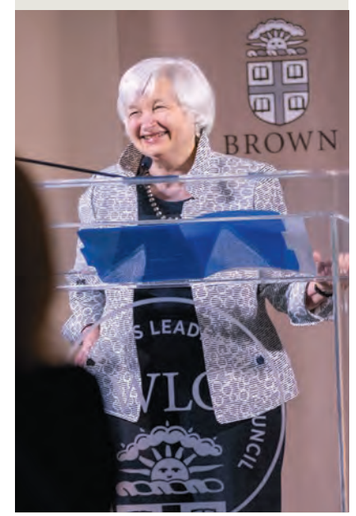
The findings, published in *Nature Communications*, can be used to explain motivation as well as to figure out what's going on when someone is lacking in it. Said Shenhav, study author and an assistant professor of cognitive, linguistic, and psychological sciences, "This work helps us answer bigger-picture questions such as how people perceive the incentives in their environment and how they determine that their efforts are worthwhile."

—CORRIE PIKUL

KINDRA CLINEFF

ALUMNI IMPACT

JANET YELLEN PHD '67, LLD '98 HON. is former chair of the Federal Reserve and was tapped in 2021 to serve as Secretary of the Treasury for the Biden Administration; she is the first woman to perform either role. She concentrated in economics at Pembroke College, Brown University's former women's college. In a virtual address to the Greater Providence Chamber of Commerce on November 22, 2021, Yellen credited her experiences at Pembroke with helping her get to where she is today: "I might not have ended up at the Treasury otherwise."



U.S. Treasury Secretary Janet Yellen speaks at the 125 Years of Women at Brown Conference, May 5, 2017.

BROWN UNIVERSITY; ADOBESTOCK

Past Disaster Predicts Future Trauma

Past stressors can increase vulnerability to mental illnesses like depression and PTSD.

WHAT DOESN'T KILL YOU MAKES YOU STRONGER—that claim is so universally accepted that it's a common truism in contexts from everyday conversations to Top 40 pop charts. But new research led by a team of Brown University researchers finds that this is false.

In fact, the research suggests that the opposite is true: past stressors sensitize people to future traumas, thereby increasing their chances of developing a mental health disorder.

The study, published in the *British Journal of Psychiatry* on June 11, 2020, was a collaborative effort led by scientists at Brown and the University of Concepción in Chile.

The team examined 1,160 Chileans in 2003 and 2011, both before and after the sixth-most-powerful earthquake on record and subsequent tsunami struck their country in 2010. When the study began in 2003, none of the participants had a history of posttraumatic stress disorder (PTSD) or major depressive disorder (MDD). After the 2010 earthquake, 9.1% of the survivors were diagnosed with PTSD and 14.4% with MDD.

The risk of developing these disorders was particularly high among individuals who experienced multiple predisaster stressors, such as serious illness or injury, death of a loved one, divorce, unemployment or financial struggles, legal troubles, or loss of a valuable possession.

"We hope that this research will spur interest in the face of the increasing number of natural disasters per year—a major consequence of climate change—such as the devastating earthquake that affected Chile and neighboring countries," said **CRISTINA FERNANDEZ**, the study's lead author, who is a psychiatric epidemiologist and Brown postdoctoral research fellow. "The immediate global impacts of these catastrophic events on disease, death, and the economy are largely well recognized." —KERRY BENSON

Deep Brain Stimulation Gets Responsive

Bioengineers develop adaptive DBS to adjust therapy as needed.

BY DELIVERING SMALL ELECTRICAL PULSES directly to the brain, deep brain stimulation (DBS) can ease tremors associated with Parkinson's disease, help relieve chronic pain, and even improve treatment for obsessive compulsive disorder (OCD) and depression. The technique works well for some patients, but researchers would like to make DBS devices a little smarter by adding the capability to sense activity in the brain and adapt the intensity of stimulation in real time.

Brown University bioengineers have taken important steps toward creating adaptive DBS technology. *Nature Medicine* recently published the results of one study focused on identifying brain signals associated with OCD symptoms to treat the disease. OCD affects as much as 2% of the world's population and can cause recurring unwanted thoughts and repetitive behaviors. The disorder is often debilitating, and up to 40% of cases don't respond to traditional drug or behavioral treatments.

"In order to enable adaptive DBS for OCD, we must first identify the biomarkers in the brain associated with OCD symptoms, and that is what we are working to do in this study," said **DAVID BORTON**, associate professor of engineering at Brown University, a biomedical engineer at the U.S. Department of Veterans Affairs Center for Neurorestoration and Neurotechnology, and senior author of the study.

Led by Nicole Provenza '21, a biomedical engineering PhD graduate from Borton's laboratory, the research team collected brain signal data and a suite of behavioral biomarkers from study participants in both clinical and home settings. "This is the first time brain signals from participants with neuropsychiatric illness have been recorded chronically at home alongside relevant behavioral measures," Provenza said. "Using these brain signals, we may be able to differentiate between when someone is experiencing OCD symptoms and when they are not, and this technique made it possible to record this diversity of behavior and brain activity."

As the study advances to the next phase, signals recorded deep in the brain will now be considered along with signals from a second region of the brain, the orbital frontal cortex. Both regions are thought to play a role in OCD and other psychiatric disorders.

Ayan Waite, a doctoral student in electrical engineering, studies the connectivity between the two regions and represents the relationship mathematically. That relationship can then be used as a control policy that continuously responds to neural data, modifying stimulation as necessary to reduce OCD symptoms.

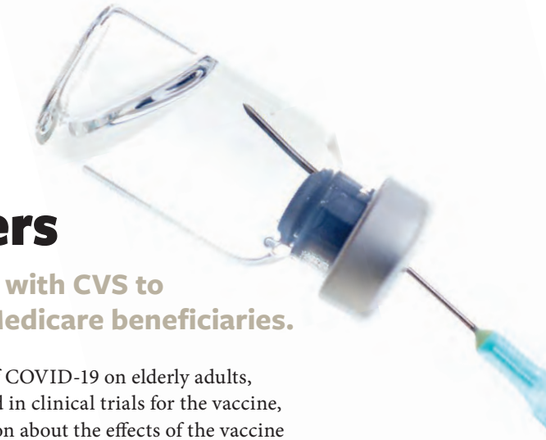
Meanwhile, biomedical engineering doctoral student Michaela Alarie is looking for new sets of biomarkers in the orbital frontal cortex.

"I'm interested in looking at one behavior that someone with OCD might experience, such as pathological doubt or inflexibility, and seeing if there are any neurobiomarkers that represent that specific behavior," Alarie said.

Once a biomarker is identified, Waite can incorporate it into new closed-loop stimulation systems. "The work I'm doing now with closed-loop controls would be a very preliminary design," said Waite. "There's still so much to understand about mood and how it changes over time." —KEVIN STACEY

Associate Professor of Engineering David Borton (right) demonstrates a deep brain stimulation device to doctoral students Michaela Alarie (left) and Ayan Waite (center).

DEIRDRE CONFAR



Vaccine Safety in Elders

A Brown-based research team partners with CVS to monitor COVID-19 vaccine effects for Medicare beneficiaries.

Vincent Mor, professor of health services, policy, and practice

DESPITE THE DISPROPORTIONATE IMPACT of COVID-19 on elderly adults, this population was largely underrepresented in clinical trials for the vaccine, and there is a significant need for information about the effects of the vaccine on this vulnerable population.

The National Institute on Aging (NIA) awarded $2.5 million to a research team based at Brown University and Hebrew SeniorLife to partner with CVS Health and develop a massive, data-driven monitoring system that tracks the long-term safety and efficacy of COVID-19 vaccinations for Medicare beneficiaries.

The researchers say members of this group, who are age 65 and older and tend to have more diagnoses of Alzheimer's disease, dementia, and other disorders, are at greatest risk for severe illness from the coronavirus.

"We'll be able to determine the prevalence of known adverse reactions to the vaccine and whether it protects them from coming down with COVID in the future," said project leader **VINCENT MOR**, the Florence Pirce Grant University Professor and professor of health services, policy, and practice at the Brown University School of Public Health.

The two-year project is a supplement to the largest federal award in University history: a $54 million NIA grant awarded to Brown and Hebrew SeniorLife in 2019 to fund the IMPACT Collaboratory, a nationwide effort to improve health care and quality of life for people living with Alzheimer's disease and related dementias, as well as their caregivers.

Mor, coleader of the IMPACT Collaboratory and a longtime advocate for vulnerable elders, was recognized for the impact of his service, leadership, and research over four decades at Brown when he was awarded the faculty's highest honor: the Susan Colver Rosenberger Medal. —CORRIE PIKUL

ALUMNI IMPACT

MARIA ZUBER SCM'83, PHD'86, SCD'08 HON., P'11 is vice president for research at MIT and cochair of the President's Council of Advisors on Science and Technology. She earned her ScM and PhD in geophysics at Brown and currently serves on the Corporation of Brown University Board of Trustees.

"It was during my time in graduate school at Brown when I came to the realization that I was capable of addressing any question that I wanted, as long as I was willing to simplify it to the point where I had a problem that I could actually solve. It was a lesson I use often in a career of breaking down what I call classic 'wicked hard problems' into tractable pieces. In today's complex world, there are many such problems, from how to create equitable societies to how do we remove carbon from the world's energy system."

— Excerpted from her remarks at Brown's 2021 Celebration of Research

COURTESY MARIA ZUBER; NICK DENTAMARO/BROWN UNIVERSITY; ISTOCK

Kavita Ramanan, professor of applied mathematics (right), discusses computations with a student at ICERM.

NICK DENTAMARO/BROWN UNIVERSITY

Mathematician Receives Two Top Honors

Applied mathematics research leads to American Academy of Arts & Sciences and Vannevar Bush Faculty Fellowship awards.

KAVITA RAMANAN, probability theorist and Roland George Dwight Richardson University Professor of Applied Mathematics, received two prestigious national recognitions in 2021—election to the American Academy of Arts & Sciences and selection by the U.S. Department of Defense as a Vannevar Bush Faculty Fellow.

Founded in 1780, the American Academy of Arts & Sciences selects its members through a highly competitive process that recognizes individuals who have made preeminent contributions to their disciplines and to society at large. Ramanan was elected as one of seven new members of Class I – Mathematical and Physical Sciences.

"I am deeply honored by this recognition, which came as a completely unexpected surprise," Ramanan said. "I am greatly indebted to my partner, my family, and close friends, as well as mentors, collaborators, and students, for not only making my research journey possible but also extremely enjoyable. In addition, I find the multidisciplinary nature of the American Academy of Arts & Sciences very attractive and am excited by the possibility of meeting and working with people from diverse fields as a member of the academy."

As the largest single-investigator award program at the Department of Defense, the Vannevar Bush Faculty Fellowship is highly competitive. Ramanan was selected as one of eight fellows from more than 300 submissions. Her research topic is "High-dimensional Stochastic Dynamics on Diverse Network Topologies."

Ramanan's research focuses on probability theory and stochastic processes. Her work investigates the uncertain outcomes and random effects that pervade science, engineering, and everyday life.

"We sometimes think of randomness as a problem—something we want to get rid of," Ramanan said. "But it turns out that introducing randomness can be highly beneficial in many areas of mathematics and its applications."

Ramanan has pioneered mathematical tools used to analyze random behavior in areas as disparate as the geometry of high-dimensional objects, the physics of phase transitions, and the ways in which lines and queues form. These tools help analyze high-dimensional data and predict important outcomes such as the spread of disease, the performance of algorithms for cloud computing, and the synchronization of circadian rhythms. She is the owner of four patents dealing with scheduling in wireless communication data networks.

Ramanan has also pioneered opportunities for communicating math to diverse audiences. She founded the Math CoOp for volunteers to share their passion for math with area schools, and initiated Mathematics Sin Fronteras, a bilingual math outreach program for undergraduate students across South, Central, and North America. She served on the executive committee of the Association for Women in Mathematics (AWM) for a five-year term from 2018 to 2022 and helped establish the AWM student chapter at Brown. —KEVIN STACEY

ADOBESTOCK

Segregated Movement in Cities

133 million tweets show racial segregation where people choose to eat, drink, shop, socialize, and travel.

THE HISTORY OF RACIAL SEGREGATION in American cities is a painful one—and one that has mapped itself irreversibly onto neighborhoods across the country. But just how far-reaching are its implications?

Assistant Professor of Sociology **JENNIFER CANDIPAN** has begun to answer that question with her recent research. By combing through geotags from 133 million tweets from 375,000 Twitter users in 50 American cities, Candipan and her team have found that different racial groups often don't frequent the same restaurants, parks, bars, and modes of transportation, even when living in the same city.

Candipan's work, which utilizes geotagged social media data to construct a novel mobility-based segregation index, reveals that not just housing but everyday patterns of movement are more segregated than previously known.

"Some cities have long histories of preventing people of color from living in majority-white neighborhoods through racist housing policies and restrictive racial covenants," she said. "It makes sense that we see that segregation borne out in people's movements as well. If you live in a city with segregated neighborhoods, you're more likely to move in segregated social circles and spend time in neighborhoods full of people who look like you, and avoid places where you've been excluded."

The cities with the most highly segregated movement patterns are those with many Black residents and especially fraught histories of racial conflict, such as Detroit, Philadelphia, and Atlanta.

Candipan says her findings were not necessarily surprising but that they can inform strategies for unraveling the legacies of segregation in our cities. For one, her research shows a link between highly segregated housing in cities and elevated rates of segregated movement, suggesting that improvements in affordable housing and transportation could help desegregate movement as well.

"It is clear that to this day, racial hierarchies remain and white Americans remain on top," Candipan said. "It's time for us to recognize the extent of that segregation and to try to address it—because at the very least, everyone should be able to go where they want, when they want."
—OLIVIA BURDETTE '22.5

Infant Health Inequality Returns

U.S. must solve food insecurity, the high cost of health care, and homelessness to create equality of opportunity.

Emily Rauscher, associate professor of sociology

David Rangel, assistant professor of education

THROUGHOUT THE 1990s AND 2000s, infant health inequality was improving. But that trend began to reverse in 2010, creating an ever-widening gulf whose ramifications could be felt for generations.

That's according to a study authored by **EMILY RAUSCHER** and **DAVID RANGEL**, two researchers affiliated with Brown's Population Studies and Training Center. Their findings were published in December 2020 in the journal *Social Science & Medicine – Population Health*.

The pair found that between 1989 and 2010, the health gap between infants born to the most socially advantaged mothers—those who are married, highly educated, and white—and infants born to the least socially advantaged mothers—those who are unmarried, without a high school diploma, and Black—steadily decreased. But beginning in 2010, that positive trend reversed course.

The change is a concern, the authors explained, because multiple studies have shown that when infants are born underweight or more than three weeks before their due date, they may face complications that could affect mental, physical, and economic well-being for years to come. Research literature shows that those health complications are more likely to occur in infants born to mothers who face social and economic disadvantages.

"Lots of Americans view the U.S. as a land of equal opportunity where hard work pays off," said Rauscher, an associate professor of sociology at Brown. "But equality of opportunity is fundamentally impossible to achieve as long as there is inequality in infant health. When babies are born in underresourced communities, they are more likely to be born underweight or malnourished. They're already at a disadvantage before they've even had an opportunity to do anything in the world."—JILL KIMBALL

Economic Outrage

Angrynomics suggests Westerners are angry over the state of the economy and offers a fix for broken capitalist systems.

THE ECONOMIST JOHN MAYNARD KEYNES once said, "The difficulty lies not so much in developing new ideas as in escaping from old ones."

Brown political economist **MARK BLYTH** agrees—and his new book, *Angrynomics*, details the outrage citizens feel when old, irrelevant economic ideas endure to the detriment of most of society.

Angrynomics, coauthored by Blyth, the William R. Rhodes '57 Professor of International Economics, and macro hedge fund manager and economist Eric Lonergan, uses a computer analogy to explore why measures of stress and anxiety are on the rise even as the vast majority of people have grown wealthier than ever.

All capitalist economies, the authors explain in the book, are like computers: they contain the same hardware, but each economy arranges the parts differently. Over time, economic ideas accumulate bugs that crash countries' respective societal machines. And as crashes become more frequent, societal anger mounts.

Economic experts and the political establishment have been slow to offer prescriptions to treat or fix the broken American economy, Blyth said—which has created an opening for political outsiders to swoop in, weaponize citizens' anger, seize power and develop authoritarian regimes.

Continued deregulation and advice from technocrats won't solve yawning wealth gaps in Western economies, the authors argue in the book, and they propose giving citizens a stable, transparent financial stake in their societies through a sovereign wealth fund like that of Norway.

"Why don't we, rather than private equity, just issue more bonds, buy up all those assets, and put them in a completely passive fund miles away from all the politicians? You would have a multitrillion-dollar wealth fund, for colleges, for health care reform," Blyth said. "It could actually make a difference in people's lives."
—JILL KIMBALL

Mark Blyth, professor of international and public affairs

Disrupting Cancer Progression

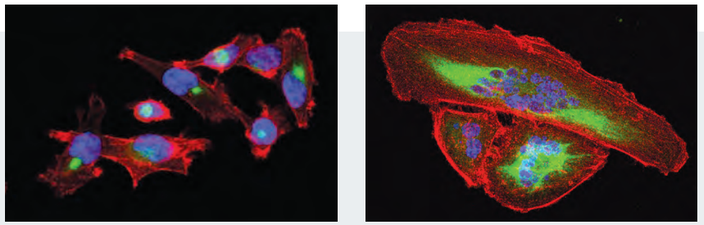
Filaments called vimentin may be key to the spread of aggressive, chemoresistant cancer cells.

ONE CHALLENGE FACED by researchers and medical professionals working to develop new treatments for cancer is the presence of multiple kinds of cancer cells within the same tumor. Often these "mosaic" tumors include cells, such as polyploid giant cancer cells (PGCCs), that have evolved to become aggressive and resistant to chemotherapy and radiation.

A study by Brown researchers published in *Proceedings of the National Academy of Sciences* expands the understanding of these previously overlooked cancer cells and identifies a potential target for treating them.

Unlike most cancer cells that divide by mitosis, PGCCs undergo amitotic budding and then rapidly spread using filaments called vimentin. When replicating cells proliferate and become jammed together, vimentin provides PGCCs with a more flexible, elastic structure, which helps protect them from damage and allows them to squeeze past neighboring cells to escape to less-crowded areas. ►

UNSPLASH; NICK DENTAMARO/BROWN UNIVERSITY



MDA-MB-231 control and polyploid giant cancer cells (PGCCs) were stained for actin (red), vimentin (green), and nuclei (blue). In control cells (left), condensed vimentin appeared in the perinuclear region of the cells, whereas PGCCs (right) displayed more distributed vimentin structure.

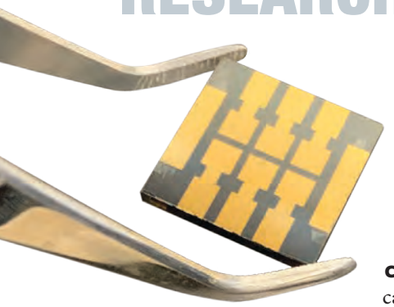
COURTESY MICHELLE DAWSON; KINDRA CLINEFF

The researchers found that compared to control cells, PGCCs have a greater amount of vimentin, and the filaments tend to be more evenly distributed throughout these types of cells. In their work, when the researchers disrupted vimentin, they dramatically reduced the cells' ability to move.

"This study shows vimentin is overexpressed in PGCCs and is likely responsible for several of their abnormal behaviors," said study author **MICHELLE DAWSON**, assistant professor of molecular biology, cell biology, and biochemistry.

"Vimentin is a ubiquitous protein, so targeting it directly may not be an answer, but drugs that target vimentin interactions may be effective in limiting the effects of these cells."

As a next step, Dawson and colleagues hope to find a biomarker for PGCCs so that they can study these cells in human tumors. —KERRY BENSON



Next-Generation Solar Cells

Researchers strengthen a key weak point in perovskite solar cells, a clean energy technology.

CRYSTALLINE MATERIALS called perovskites are a promising candidate for making next-generation solar cells that are far less expensive than today's silicon-based cells. However, although the efficiency with which perovskite cells convert sunlight to electricity has improved markedly in recent years—and now rivals the efficiency of silicon—there are concerns about the long-term reliability of perovskites.

"The final hurdle to be cleared before the technology can be widely available is reliability—making cells that maintain their performance over time," said **NITIN PADTURE**, Brown professor of engineering. "That's one of the things my research group has been working on, and we're happy to report some important progress."

Part of the problem has to do with the layering required to make a functioning perovskite cell. Each cell contains five or more distinct layers, each performing a different function in the electricity-generation process. Since these layers are made from different materials, they respond differently to external forces.

For example, temperature changes that occur during the manufacturing process and during service can cause some layers to expand or contract more than others. That creates mechanical stresses at the layer interfaces that can cause the layers to decouple. If the interfaces are compromised, the performance of the cell plummets.

In research published in the journal *Science*, Padture demonstrated a method for strengthening the weakest of those layer interfaces. He and his students developed a "molecular glue" that strengthens the bond between layers and nearly doubles cell life.

"This is the kind of research that's required in order to make cells that are inexpensive, efficient, and perform well for decades," Padture said. —KEVIN STACEY

The Cost of a Gunshot

Health care costs skyrocket in the six months after a firearm injury.

THE INCIDENCE OF FIREARM INJURY AND DEATH in the United States is increasing, and although the impact of these injuries on health care providers is estimated to be high, research to date has not investigated data on pre- and post-injury health care visits and related costs.

To close that gap, a team led by **MEGAN RANNEY**—an emergency physician and professor of emergency medicine and health services, policy, and practice at Brown—conducted a study that found that in the six months after surviving a firearm injury, patient health care costs increased three to 20 times depending on whether the person was hospitalized, compared to the six months prior to injury.

The findings were published in the Sept. 29, 2020, issue of the journal *Annals of Internal Medicine*.

In comparing the six-month periods before and after the initial firearm injury visit, the number of insurance claims increased 187% for patients discharged from the emergency department (ED) and 608% for those hospitalized.

In dollars, that translates to total initial health care costs of $8.2 million for firearm injuries that were discharged from the ED and $41.2 million for ED visits that ended with hospital admission.

"It adds to the literature in a different way, showing that firearm injury is super expensive, not just at the time that someone's hurt but also going forward," Ranney said. "This study shows just a snippet of the overall costs, and so therefore my call is for insurers and governments and health care systems to take this on as an imperative for prevention." —MAGGIE SPEAR

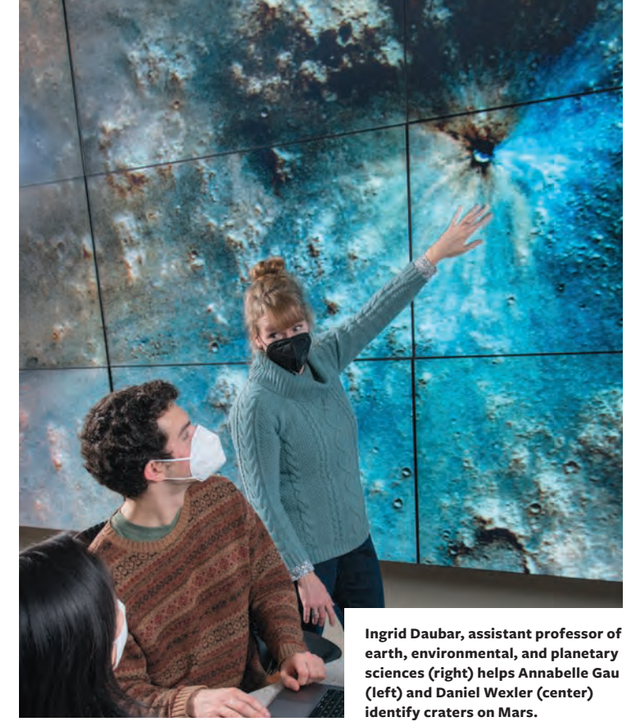
THERESA JOHNSON HERLIHY; ISTOCK; ZHENGHONG DAI/PADTURE LAB

ALUMNI IMPACT

HARRY WILLIAM HOLT JR. '84, P'16 is vice president of operations at BITHGROUP Technologies. His responsibilities include overseeing the company's community outreach and internship programs. At Brown, he received his degree in chemical engineering.

"When I was at Brown, I was fortunate to have three chemical engineering internships during the summers. One involved boiler water chemistry, the second was working at a carbon manufacturing plant. The third was at a polymer manufacturing plant. I worked with Professor Edward T. Kornhauser during my junior year in exploring whether the shape and sizes of vessels had any impact on the absorption qualities of carbons from various sources. Experiential classroom learning allowed me to develop as a young engineer and figure out how to apply what I learned in the classroom to a real-world environment."

SAM MARKOSE/TRUELIFESTUDIO.COM; DEIRDRE CONFAR



Ingrid Daubar, assistant professor of earth, environmental, and planetary sciences (right) helps Annabelle Gau (left) and Daniel Wexler (center) identify craters on Mars.

Crater Hunting

Professor and NASA scientist trains students to verify fresh crater impacts on Mars for artificial intelligence study.

BILLIONS OF YEARS AGO, flowing rivers and erupting volcanoes were the dominant processes that reshaped the surface of Mars. A regular battering from small meteoroids continues to sculpt the planet's surface, and NASA—with the help of a few Brown students—is using a new artificial intelligence (AI) technique to locate those fresh craters.

INGRID DAUBAR, a senior research associate at Brown who also works at NASA's Jet Propulsion Laboratory (JPL), has studied fresh impacts on Mars for years. The hope is that the AI classifier may speed the discovery of new impacts on Mars, and there are plenty of reasons to be interested in fresh craters, Dauber says.

"They provide us with a window into the subsurface," she said. "Some of these fresh impacts have actually exposed subsurface water ice, for example."

Two Brown undergraduates, Annabel Gau and Daniel Wexler, have been verifying dozens of possible fresh craters. In order to do the work, Gao and Wexler needed to become expert crater hunters themselves, which they did in collaboration with Daubar.

"What we're looking for is the ejecta around the crater," Gao said. "When an impactor comes in, it sprays dust out from the crater that's a little darker than the dust on the surface. That's what we're looking for."

"I think it's going to be really interesting to see if the AI algorithm is finding craters in different places or of different sizes, or if there's some other characteristic that makes them harder for humans to find," said Daubar. "And once we have that integrated dataset, will it tell us something new about Mars? That's really the fun part."—KEVIN STACEY

BBII Funds Biomedical Breakthroughs

Four research teams receive innovation grants to bring medical products to the market.

IN ITS THIRD ANNUAL CYCLE, Brown Biomedical Innovations to Impact (BBII) awarded four research teams up to $100,000 each to accelerate the translation of their scientific discoveries into commercial products that could benefit patients facing urgent medical challenges.

As an accelerator fund that supports academic biomedical technologies, BBII is run by the University's Division of Biology and Medicine in collaboration with Brown Technology Innovations, part of the Office of the Vice President for Research.

The endoscopic camera captures a wide-angle view of the entire operative field. Each surgeon views their own close-up of the field, centered around their instrument (i.e., orange or green).

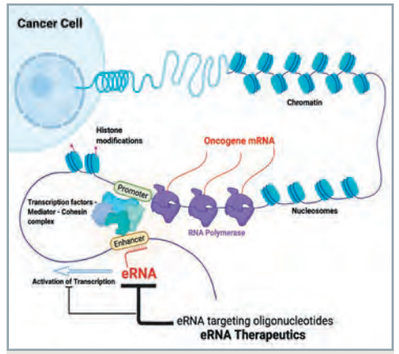
FRANCOIS LUKS, a professor of surgery, pediatrics, obstetrics, and gynecology, is developing a system called driver-assisted videoscopic surgery (DAVID) that offers the possibility of a large change in minimally invasive surgery (MIS): the ability to splice input from a single endoscopic camera into multiple images that can be viewed and manipulated independently by multiple clinicians on a patient care team.

PROJECT AWARDEES

ERIC MORROW, the Mencoff Family Professor of Biology, professor of neuroscience, professor of psychiatry and human behavior, and director of the Center for Translational Neuroscience at the Carney Institute for Brain Science, is identifying and testing potential treatment strategies that prevent development and progression of a rare genetic disorder called GPT2 deficiency.

Blanche Ip works with silicone molds used to make microtissues with human cells.

JEFFREY MORGAN, a professor of pathology and laboratory medicine and professor of engineering; **BLANCHE IP**, an assistant professor of pathology and laboratory medicine (research); and **FRANK SELLKE**, Karl E. Karlson, MD and Gloria A. Karlson Professor of Cardiothoracic Surgery and chief of cardiothoracic surgery at Rhode Island Hospital, are advancing their method of producing lab-grown, human-derived tissue to fabricate biomaterials for cardiac repair after a heart attack, a significantly less invasive procedure than a heart transplant.



Schematic illustration of Tapinos Lab research on eRNA therapeutics for brain tumors

NIKOS TAPINOS, Sidney A. Fox and Dorothea Doctors Fox Associate Professor of Ophthalmology, Visual Science, and Neuroscience, is discovering and developing drugs to interfere with enhancer RNA (eRNA) molecular targets in order to stop the growth of a type of cancer cell called glioma stem cells (GSCs) and change the treatment course for glioblastoma, the most prevalent and aggressive type of brain tumor.

COURTESY NIKOS TAPINOS; KINDRA CLINEFF (IP, MORGAN, SELLKE PHOTOS); COURTESY FRANCOIS LUKS; COURTESY ERIC MORROW; ILLUSTRATION BY FRANCOIS LUKS

SHORT TAKES

—KATHLEEN MEININGER '23

In a paper published in *Science*, Assistant Professor of Physics **Jia (Leo) Li** and colleagues demonstrated for the first time that in magic-angle graphene—a superconductor material that can conduct electricity with zero resistance—weakening electron-electron Coulomb interactions strengthens superconductivity.

Visiting Professor of Economics Jesse Shapiro was named one of 25 MacArthur Fellows nationwide, receiving a $625,000 "genius grant" from the foundation to advance his research using novel methods of economic theory and data analysis to address political polarization, media bias, and other complex social issues.

For her research into chemical computing, an innovative technology that uses collections of small molecules for more efficient data storage, *Popular Science* named **Brenda Rubenstein**, associate professor of chemistry, as one of 2021's Brilliant 10, its annual roster of 10 innovators "taking on society's biggest challenges across the world."

The national debate on school reopening during the pandemic was informed by Royce Family Professor of Teaching Excellence and Professor of Economics Emily Oster, an expert in health economics and statistical methods who built the COVID-19 School Response Dashboard to collect data on case rates from schools in 49 states and the District of Columbia.

DR. JOHN GOLDSMITH/ CELESTIAL VISIONS (2012)

The National Science Foundation awarded $1.2 million to an international group of scientists led by Assistant Professor of Physics **Jonathan Pober** to use the highly-sensitive Murchison Widefield Array radio telescope in search of a 12-billion-year-old molecular signal marking the birth of the first stars lighting up our universe.

"Climate change is the defining crisis of our time. Brown is rising to the challenge. I see more students, staff, and faculty every day getting motivated to do something and putting in the time to find answers and solutions."

— DOV SAX, INTERIM DIRECTOR OF THE INSTITUTE AT BROWN FOR ENVIRONMENT AND SOCIETY

TURNING UP THE HEAT on Climate Change Solutions

Brown researchers take action as Earth's temperature rises.

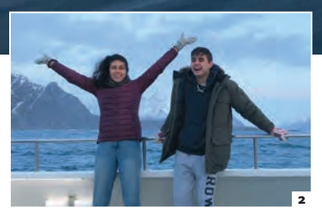
BY DEBRA BRADLEY RUDER '80

COURTESY LAURENCE SMITH

Professor Laurence Smith (right) and graduate student Lincoln Pitcher (UCLA) setting up time-lapse cameras to track ocean-going Greenland Ice Sheet meltwater runoff entering the Isortoq River, SW Greenland.

1

1. View from Svolvær on the Lofoten Peninsula in Norway, where students met with traditional fishers to learn the impact of hydrocarbon exploration on fish populations
2. Brown students Chiara Wadsworth Arellano and Kimber Brain
3. William Talleri (Babson), Nhu Phung (Brown), Chiara Wadsworth Arellano, Vida Steiro (Brown TA), Brooke Majewski (Babson), Olivia Thorson (Brown), Tom Dulski (Babson) and Kimber Brain
4. Staff from Bodø Municipality in Norway discuss the withdrawal of the NATO airbase from the city and their ideas to create a low-emissions city development pathway.



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AS EXTREME STORMS, FLOODS, WILDFIRES, DROUGHTS, AND HEAT WAVES from our warming Earth continue to wreak havoc and heartache around the world, Brown has intensified its focus on climate change through solutions-focused research, innovative teaching, and creative collaborations that transcend disciplinary boundaries.

"There are a lot of people at Brown putting this problem front and center, because climate change is the great global challenge of our time," says Jeff Colgan, Richard Holbrooke Associate Professor of Political Science and director of Brown's Climate Solutions Lab.

Climate change investigations at Brown are happening throughout the natural sciences, social sciences, and humanities. From developing catalysts that could help recycle atmospheric carbon dioxide to uncovering industry tactics that thwart climate action, faculty, students, and staff are working on ways to help us understand, adapt to, and mitigate the potentially catastrophic effects of climate change, which will impact every region on the planet and take a disproportionate toll on the world's most disadvantaged communities.

SHIFTING ICESCAPES

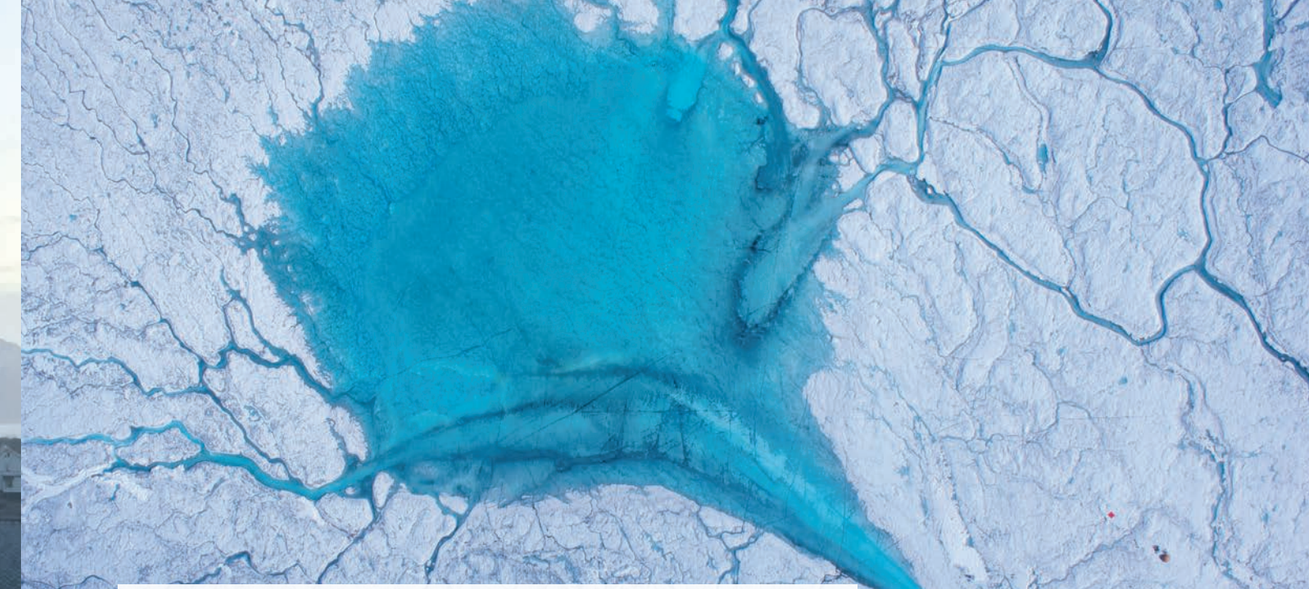
No region is heating up faster than the Arctic, and Brown researchers associated with the Institute at Brown for Environment and Society (IBES) are examining the rapid social, economic, geopolitical, and environmental changes underway there.

Climate science and policy expert Amanda Lynch, Sloan Lindemann and George Lindemann Jr. Distinguished Professor of Environmental Studies and professor of earth, environmental, and planetary sciences, is studying the ramifications of melting sea ice in the Arctic, a region that has captured her attention for decades.

The retreating ice threatens hunting and fishing by Indigenous and traditional non-Indigenous communities, but it also expands opportunities for industry—such as international shipping routes and natural resources mining—in this once-impassable part of the globe.

"I'm thinking a lot about the way in which the loss of ice is driving aspirations and expectations for human activities in the Arctic and what that means for the people who live there, the global climate, and geopolitics," Lynch noted.

COURTESY AMANDA LYNCH



The process of ice loss is complex. Scientists have a good handle on how an ice-free Arctic will look around the year 2100, Lynch said, "but getting from here to there is really hard. The ice doesn't retreat cleanly."

Six Brown undergraduates witnessed these processes firsthand with Lynch on a memorable Winter Session trip to Norway's Arctic coast with students and faculty from two other universities.

Working in 24/7 darkness, the group met people on the front lines of climate change, from traditional fishers to town planners to cruise ship operators, and conducted research on climate change's effects on six Arctic nations. "They saw that the Arctic is not just polar bears on ice floes," Lynch said.

Lynch and water specialist Laurence C. Smith, John Atwater and Diana Nelson University Professor of Environmental Studies and professor of earth, environmental, and planetary sciences, are now coleading a five-year, multi-institution project with National Science Foundation funding to gather data on hotspots of emerging development in the Arctic (like the port town of Kirkenes in northern Norway) and to assess how that development may affect the Arctic environment and its people.

Smith's Arctic research also involves deploying remote sensing technology (such as satellites and drones) and cutting-edge fieldwork to study surface water dynamics.

His team pioneered techniques for measuring how quickly water is flowing off the Greenland ice sheet—a major contributor to global sea level rise—using a sophisticated radar device that the scientists, on the slippery banks of a glacial "river," painstakingly draw back and forth across the raging waters. Their treacherous missions have revealed that virtually all the melting ice is lost to the ocean.

HISTORIES OF CHANGE

Environmental historian Bathsheba Demuth studies the Russian and North American Arctic to illuminate the relationships between humans, societies, and nature. Her deep connection to the Arctic began at age 18, when she moved from her Iowa hometown to a remote Indigenous village in the Yukon for a life-changing gap experience before college.

For more than two years, she mushed huskies, hunted caribou,

COURTESY LAURENCE SMITH; MIA BENNETT; BROWN/IBES POSTDOCTORAL SCHOLAR JOHNNY RYAN

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5. Drone photo of glacier lake showing base camp (red dots) and funneling of surface meltwater measured at this site
6. Collecting images and surface topography measurements from the helicopter
7. Helicopter departs, leaving researchers and equipment to conduct water studies.
8. Researchers sample water volume of a glacier river that catches surface meltwater.

ELECTROCHEMIST AND MATERIALS ENGINEER G. Tayhas Palmore, Elaine I. Savage Professor of Engineering, and doctoral student Taehee Kim reported a way to develop a highly efficient copper catalyst that, by converting carbon dioxide into complex hydrocarbons, holds promise for aiding large-scale recycling of excess CO_2 in the atmosphere.

IN RESEARCH PAPERS AND CONGRESSIONAL TESTIMONY, Myles Lennon, Dean's Assistant Professor of Environment and Society and Anthropology, offered solutions to improve clean energy technology to protect low-income communities and communities of color from such harms as toxic chemical dumping.

9. Bathsheba Demuth, assistant professor of history and environment and society
10 and 11. Images from the Porcupine and Bell Rivers (tributaries of the Yukon River)

tracked bears, and embraced the perspective of the nonhuman. Arctic communities have felt climate change for decades, she said. "Even when I first went north 20 years ago, people were saying, 'You're experiencing one of the last normal summers.'"

Demuth, an assistant professor of history and environment and society, has an Andrew Carnegie Fellowship to conduct research on the Yukon River, a vast multinational watershed stretching from Northern Canada to Alaska. Demuth explained that the Yukon is a perfect place to study how societies have historically related to the natural world and how they manage rights (say, to pollute upstream or catch salmon downstream) as climbing temperatures alter the landscape.

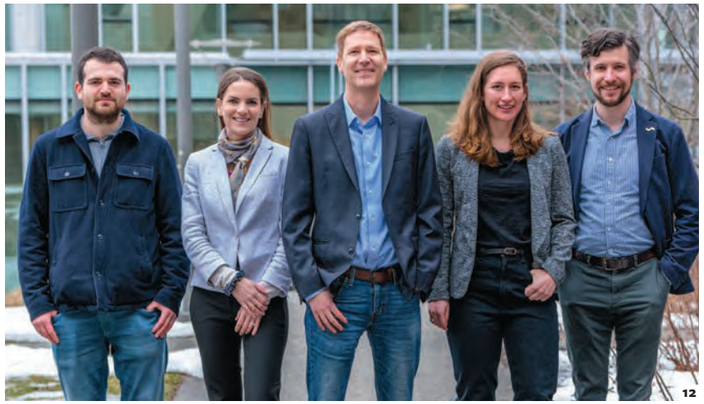
"So many political traditions overlap there—indigenous nations, the Russian and British empires, the United States and Canada," Demuth said. "All have or had ideas about how water or land, moose or geese, air or gold, should be stewarded and distributed and related to. How do we treat entities that are not people in our political decision-making? I think this question is particularly important now, as people around the globe deal with massive and continuing environmental change."

As a summer research assistant for Demuth, Brown senior Zanagee Artis '22 reviewed Indigenous people's accounts about the increased dangers of fishing in winter, including drowning, from the Yukon River's unpredictable ice thickness.

Artis, a climate justice advocate concentrating in political science and environmental studies, said that the courses he has taken with Demuth and other Brown faculty have strengthened his grasp of the scientific, legal, historical, social, and political aspects of climate issues.

They've also heightened his appreciation of the Arctic: "Growing up, I viewed the Arctic as this place that is remote and empty," Artis reflected. "But really, there's so much life and culture there."

12. The Climate Solutions Lab team, from left: Yaron Alexander Weissberg, Alice Lépissier, director of Brown's Climate Solutions Lab Jeff Colgan, Miriam Hinthorn, Alexander Sayer Gard-Murray



REMEDIES FOR A CRISIS

Finding solutions is at the heart of Brown's climate change work. In the fall of 2020 Brown launched the Climate Solutions Initiative to overcome obstacles to meaningful action on climate change through new and existing University-led efforts.

Locally, the initiative encompasses plans to bring together city officials, developers, and clean energy experts to reduce emissions in Providence, and to share lessons from Brown's campus sustainability program with other universities. The Climate Solutions Initiative also seeks to catalyze results at the regional, national, and global levels.

One project of the initiative is the Climate Solutions Lab, based at Brown's Watson Institute for International and Public Affairs and established to stimulate collaborative scholarship among Watson social scientists in such climate-adjacent fields as energy, trade, and finance.

Advocating nonpartisan policy ideas on climate change through outreach with legislators, media outlets, and others is one way the lab makes an impact. "The idea is to get some of the policy recommendations that have been floating around academia into the hands of people who can take them further," said lab leader Colgan, an energy policy expert.

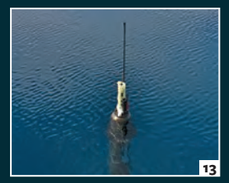
New solutions-themed courses are on the rise, including Colgan's Politics of Climate Change, which explores the economic and societal transformations needed to mitigate climate change—for example, placing tariffs on steel, glass, and other carbon-intensive products coming into the European Union to push other countries to lower their emissions.

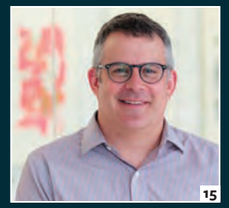
Colgan said that multiple students told him they appreciated the course's positive approach: "All of their lives, they've been hearing the doom and gloom about climate change. This was the first time many of them were hearing about what we could do to address the problem."

Colgan contributed his syllabus to the Climate Solutions Lab's Syllabus Bank, a free resource to help university educators worldwide teach climate change courses. During its first year, it collected nearly 60 syllabi and had more than 2,000 downloads for such courses as Climate Geoengineering and Power, Justice, and Climate Change.

Political science concentrator Kelly Raymond '21 came up with her own solutions through her honors thesis

DEIRDRE CONFAR; COURTESY BATHSHEBA DEMUTH (RIVER, MOOSE); JESSE BURKE





13. Nearly 4,000 Argo nautical robots collect temperature data across the oceans and show a consistent warming trend over the last two decades.
14. The IPCC's Sixth Assessment Report on climate change, authored by hundreds of scientists from 65 countries
15. Baylor Fox-Kemper, professor of earth, environmental, and planetary sciences

BROWN OCEAN EXPERT COAUTHORS UNITED NATIONS CLIMATE REPORT

Baylor Fox-Kemper, professor of earth, environmental, and planetary sciences, played a key role in the sobering 2021 United Nations climate change report, *Climate Change 2021 - The Physical Science Basis*, dubbed "a code red for humanity," that signaled the planet is warming faster than expected—and that humans have the power to avoid the most disastrous effects.

Fox-Kemper, who studies the physics of oceans and is a faculty fellow of the Institute at Brown for Environment and Society, was a lead coordinating author for the report's chapter on Ocean, Cryosphere, and Sea Level Change. The daunting task meant coleading an international team of about 100 scientists evaluating the latest science in their specialties.

Contributing to the report, released by the Intergovernmental Panel on Climate Change (IPCC) in August as part of its sixth assessment, was rewarding but also triggered "climate grief" about the realities of human-caused climate change, according to Fox-Kemper. He says that we're locked into sea level rise of roughly 9 to 11 inches by 2050 from carbon emissions already in the system.

That will mean increased flooding and destruction or adaptation, especially in low-lying areas. Depending on how quickly the world curbs greenhouse gas emissions, seas are expected to rise one to three feet by 2100, and up to six feet "can't be ruled out," he warned. "Sea levels will continue to rise for centuries afterward."

While the big picture hasn't changed since the IPCC's 2014 report—"carbon dioxide in the atmosphere traps heat, and it's going to make the system warmer"— Fox-Kemper said this update reflects more precise science about how changing climate will affect regions and cause extreme flooding, droughts, fires, and heat waves around the globe.

His lab advances that science by evaluating computer models of ocean processes to see whether they match reality—for example, comparing them to temperature and salinity data collected by thousands of nautical robots—and adjusting the models accordingly.

Fox-Kemper hopes the IPCC findings "will be useful to nations, local governments, corporations, and resource managers in their decision-making and planning."

PETER GOLDBERG; ARGO PROGRAM (HTTPS://ARGO.UCSD.EDU)

UNDERGRADUATE JONATHAN BENOIT '22 studied historical satellite data of thermal pollution from a power plant in Rhode Island's Narragansett Bay to help predict how climate warming may affect wildlife and other biological systems in the area.

A 2020 STUDY COAUTHORED by Mark Bertness, professor emeritus of ecology and evolutionary biology, and some of his lab's former undergraduate researchers revealed that sea level rise has softened the soil and allowed a voracious burrowing crab species to dramatically alter salt marsh ecosystems in the southeastern United States.

16. Amanda Lynch, professor of earth, environmental, and planetary sciences
17. J. Timmons Roberts, professor of sociology
18. Laurence Smith, professor of earth, environmental, and planetary sciences
19. Visiting Professor of Environment and Society Robert Brulle
20. Dov Sax, professor of environment and society and IBES Interim Director

on decarbonization in five U.S. states. She analyzed efforts to build support for renewable energy in Texas, Colorado, Nevada, and Iowa and applied those findings to Wyoming, a top coal producer with lots of open space for wind turbines.

Raymond concluded that the right communication—stressing potential job creation, for instance—is essential for securing local buy-in. "What has made me feel optimistic during such a politically polarized period," she said, "is that there are ways to move the needle on decarbonization, and there are more people getting on board."

CLIMATE OBSTRUCTION, EXPOSED

The climate obstruction movement is another focus of cutting-edge research at Brown. Scholars say this complex network of companies, think tanks, and lobbyists has worked for decades to impede climate change progress by influencing policy and public opinion.

Detective work by IBES faculty and students has exposed some of the identities, strategies, and funding sources behind this campaign, which sociologist J. Timmons Roberts, Ittleson Professor of Environmental Studies and Sociology, explained is supported by the fossil fuel industry and includes advocates for the utility, railroad, and real estate industries.

Through the Climate Social Science Network, co-led by Roberts and Visiting Professor of Environment and Society Robert Brulle and headquartered at IBES, Brown scholars are now working with counterparts around the globe to pull back the curtain on climate change denial, delay, and disinformation.

When the pair created the international network in the fall of 2020 to spur and support collaborative research on climate obstruction, they imagined about 35 social scientists would join, yet within a year the group had swelled to 200 researchers in 22 countries.

One project underway is investigating the role of public relations spin in stalling real climate action. Others are examining topics like clean energy lobbying in U.S. statehouses, climate resistance strategies in Argentina and Brazil, and media coverage of wildfires in the United States, Canada, and Australia.

RESEARCH INFORMS POLICY

The Climate Social Science Network builds on Roberts's trailblazing work with Brown students through the Climate and Development Lab, a hands-on policy course and think tank based at IBES.

Undergraduates with the lab conduct original research, produce op-eds and policy briefs, engage with legislators and other thought leaders on climate issues—even attend UN climate talks around the world.

Kai Salem '18 developed her environmental policy chops through the lab and other engaged scholarship at Brown, including advocating with Roberts and other students for carbon tax legislation in Rhode Island. These activities helped her realize that "I can walk down the hill to the Rhode Island State House and get involved to make a difference on climate policy here."

Now policy coordinator for the Green Energy Consumers Alliance in Providence, Salem has pressed for several successful bills, including the 2021 Act on Climate (signed into law in April 2021) that commits Rhode Island to reducing greenhouse gas emissions to net zero by 2050. "These new mandatory targets," Salem said, "have already brought a sense of urgency to state actions to address climate change."

HEALTH ON A WARMING PLANET

As climate change evolves, new avenues of study will emerge. IBES Interim Director Dov Sax, a professor of environment and society, said that the institute has begun collaborating with the Brown University School of Public Health to examine the consequences for health.

Global warming causes heat waves that can aggravate respiratory conditions. Extreme weather can hamper food production, leading to famines. Tropical mosquitoes migrating from the Caribbean to a warming United States threaten to introduce deadly diseases like dengue fever, not to mention the potential for climate-related pandemics.

"The climate change angle on human health is really understudied," said Sax, who is also a professor of ecology and evolutionary biology. "We need to invest in understanding this."

ACTIONS SPEAK LOUDER

Studying what many consider an existential threat can be distressing, especially when the pace of climate solutions seems "glacial" compared to the torrent of weather disasters occurring, according to Jeff Colgan. "It's frightening," he admitted. "But I think the reality is that when we put our minds to it, humanity is capable of tremendous feats."

Amanda Lynch sees climate change as a collection of many small problems. "We don't have to solve the whole thing in one bite. What I always say is, 'It's never too late, it can always be worse, and no action is too small.' Because any action that keeps a kilogram of carbon dioxide out of the atmosphere is a good action." ■

PETER GOLDBERG; JEANNE LOEWENSTEIN; DEIRDRE CONFAR; NICK DENTAMARO/BROWN UNIVERSITY; PETER GOLDBERG

WHAT IS IBES?

Guided by the motto **"Empowering people, protecting places,"** the Institute at Brown for Environment and Society (IBES) is a cross-campus center for teaching and research on the environment. Most of the scholars highlighted in this article are connected with IBES either as core or affiliated faculty.

IBES, established in 2014 under the leadership of Professor Amanda Lynch and now steered by Professor Dov Sax, brings together students and faculty from many disciplines—climatology, ecology, sociology, international relations, and more—to build creative solutions that reflect an understanding of the natural world and human societies. Climate misinformation, the changing Arctic environment, and species conservation in a warming world are areas of IBES research strength.

Today's IBES includes 24 core faculty, many with additional appointments in academic departments; 40 affiliated faculty from across the University; and more than 75 graduate student affiliates. The institute offers undergraduate degrees in both environmental studies (AB) and environmental sciences (ScB); students can explore such topics as water and food security, air pollution, meteorology, energy and climate policy, environmental justice, and remote sensing technology.

Additionally, IBES sponsors public talks on environmental issues, cohosts the "Possibly" radio show/podcast on the science behind proposed solutions to environmental challenges, and serves as a nexus for sustainability activities at Brown and beyond.

WARNING SIGNS!

Warning signs indicate hazards that require caution and special attention. Around the world, signs are appearing with increasing frequency as rising seas, severe weather, flooding, drought, forest fires, and heat waves signal the impacts of climate change. The back cover art created by Alisa Singer (environmentalgraphiti.org) was derived from these signs.

RACHEL WETTS, ACACIA ASSISTANT PROFESSOR of Environment and Society and Sociology, analyzed nearly three decades of climate change press releases and national news articles and found that press releases with anti-climate action messaging were twice as likely to receive news coverage as those supporting climate action.

IN A STUDY OF SOUTH ASIAN MONSOONS over the past 900,000 years, Steven Clemens, associate professor of earth, environmental, and planetary sciences, and collaborators confirmed predictions that future monsoon rainfall will intensify as carbon dioxide and global temperatures rise.

UNDAUNTED

Undergraduate research despite COVID-19

BY MAURA SULLIVAN HILL

"Students, in collaboration with their faculty mentors, were encouraged to see how their projects could still be impactful. They were innovative enough to figure out how to continue these projects in ways that they wouldn't have thought about if not for the challenges that the pandemic brought."

— OLUDUROTIMI ADETUNJI, ASSOCIATE DEAN OF THE COLLEGE FOR UNDERGRADUATE RESEARCH AND INCLUSIVE SCIENCE

WITH MORE THAN A MILLION DOLLARS on hand thanks to emergency federal pandemic funding—and thousands in need of money to pay the bills and feed their families—the Rhode Island Department of Health (RIDOH) launched cash assistance and emergency food programs in just two weeks in the fall of 2020. At the center of that undertaking was Brown graduate Ella Satish '20, who had planned to be teaching English in Colombia on a gap year before medical school. When travel was cancelled because of pandemic precautions, Satish changed course, and utilizing the research and organizational skills gained from work on her Brown thesis, led a RIDOH pandemic assistance program.

Satish is just one example of how Brown students showed resilience and harnessed their research skills and interests to help others during the COVID-19 pandemic. Some projects arose to meet needs that emerged during the pandemic; others were reimaginings of work the students intended to complete on campus. Regardless, the research did not stop—Brown students found ways to continue their work, whether it was back in their hometowns or confined to their dorms or apartments in Providence.

RESILIENCE:

Continuing research in home labs

"I felt like I spent a million hours in my bedroom," **Portia Tieze** said, reflecting on the Fall 2020 remote learning semester. But she was able to escape the Zoom screens during labs for her fluid mechanics course. Even though the mechanical engineering student couldn't be in the lab at Brown, her professor's remote lab kits enabled the class to have a hands-on learning experience at home, to better understand fluid flows and the forces that drive them.

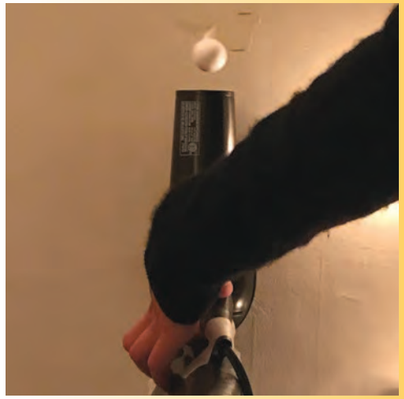
"I remember there was one lab where we had to balance a ping pong ball in the airstream of a hair dryer. I was working on the lab with one of my good friends, and we were really struggling to keep the ball in the air," she said. "It was so hilarious that we were just cracking up, and that alone was nice, to have a moment."

The goal of that experiment was to levitate the ping pong ball by applying enough air to hold the weight of the ball, thereby investigating drag forces, the same forces that enable airplanes to fly.

Tieze was also part of a team of students who worked with the course professor, Roberto Zenit, to create, test, and assemble the lab kits over the summer. The students offered essential perspective on which items their peers would readily have on hand at home. Tieze pointed out, for example, that most students wouldn't have access to a garden hose in a dorm or apartment.

"Professor Zenit wanted to make sure that we would have access to the items, like a measuring cup or corn syrup or honey, or a tray to pour it on," said Tieze, who is now a senior at Brown. Doing the experiments at home enabled her to be more independent than in the lab, she said.

"I definitely learned resilience and being adaptable. There were many moments where I thought to myself, 'I can figure this out. I could go ask the professor a million questions, or I could choose to get a little creative here,'" she said. "The labs granted us a little bit of space and flexibility in our problem solving, encouraging us to really think like engineers do."



Senior Portia Tieze helped Professor of Engineering Roberto Zenit create, assemble, and deliver lab kits for a fluid mechanics class during remote learning.

COURTESY JUSTIN RHEE; COURTESY PORTIA TIEZE

MOTIVATION:

Pursuing research at off-campus sites

While junior **Justin Rhee** was finishing his Spring 2020 Dynamics and Vibrations engineering course from his home in Southern California, he was also revamping his plans for the summer. His on-campus research had been cancelled as a safety precaution, so he was looking for local opportunities.

"After we got sent home, I saw an article published about SpaceX, that they were making face shields for nearby hospitals, and I thought that was pretty cool," Rhee said. "And the SpaceX headquarters is not too far from my house, so I submitted an intern application." ▶

Justin Rhee (right), shown here with a group of fellow summer interns, leveraged practical experience from a classroom project to earn a SpaceX internship.

SpaceX, Elon Musk's aerospace manufacturing company, is headquartered in Hawthorne, California, part of the Los Angeles metropolitan area, and Rhee is from nearby Temecula. While Rhee waited to hear back on his application for a data processing internship, he worked on a computational project for that Dynamics and Vibrations class, an addition the professor made when courses switched to remote learning. The project modeled the spread of an infection through a small community and turned out to be a deciding factor in Rhee getting the internship.

"Completing that project and having a product to show the flight surgeon at SpaceX really helped. He was pretty impressed by the data processing that was done," Rhee said.

Rhee is a student in Brown's Program in Liberal Medical Education (PLME), an eight-year program from undergraduate to medical school, and is studying electrical engineering as an undergraduate. PLME students can pursue an AB or ScB degree in any Brown concentration, whether in the humanities or behavioral, physical, or life sciences, and then finish the last four years of the program in the Medical School, culminating in the MD degree. The program is the only one of its kind in the Ivy League.

"Without Brown's educational philosophy with the open curriculum, I wouldn't have had the opportunity to work at SpaceX," Rhee said. "I probably would have been pursuing a traditional premed track and wouldn't be able to study engineering just because I want to. Studying engineering is what gave me an edge in finding this opportunity, because I don't think there are too many people who intend to go into medicine or a medically related field who are doing a pure engineering field as their undergrad degree."

"Completing that project and having a product to show the flight surgeon at SpaceX really helped. He was pretty impressed by the data processing that was done." — JUSTIN RHEE

COURTESY JUSTIN RHEE

RESPONSIVENESS:

Investigating pandemic increases in gender-based violence

Merih Deniz Toruner is only a junior at Brown but has already collaborated with the Mayo Clinic, Harvard University, and Massachusetts General Hospital. The PLME student is studying computational biology with the goal of integrating computer science into her clinical research. Toruner, a native of Turkey, engaged in oncology research at the Mayo Clinic before college; she currently works on brain cancer research in Brown's Tapinos Laboratory of Cancer Epigenetics and Plasticity.

She put all that experience into practice with the Coronavirus Visualization Team (CVT) partnership through Harvard University, which aims to involve students in research projects and share the knowledge of experts to better inform the public about coronavirus and other public health issues. Toruner is a coleader on the CVT's Project on Gender-Based Violence as part of Harvard's team, working with partners at Mass General to investigate gender-based violence during the pandemic and hosting a podcast to educate people on the issue.

"We analyzed data from the police and local shelters, and what we have found is that during the pandemic, because everyone was staying home, the gender-based violence cases were actually increasing," Toruner said. "Because a lot of shelters were closing and people were more hesitant to reach out for help or go to the ICU or the hospital to seek help. We wanted to see how we can help the public to get more informed about this, and we started the She Belongs podcast."

The podcast, she said, aims to kickstart the conversation on gender inequity. She and her coproducers interview researchers, health care experts, and first responders offering their perspectives on the increase in gender-based violence.

Judy Jang, interim associate dean of medicine for the PLME and assistant professor of medicine, said, "Deniz feels just as comfortable doing benchwork as she is working on clinical research and applications. She combines her love of biology, neuroscience, and computer science in her work and has built an impressive network of mentors across multiple institutions. When COVID-19 hit, she seamlessly transitioned much of her research online and developed the podcast, highlighting the increased vulnerability of women to violence seen during the pandemic. Deniz exemplifies the qualities of an outstanding scientist and future physician."

Merih Deniz Toruner (right) in her lab at Rhode Island Hospital running an experiment for a project that aims to develop a new treatment model for glioblastoma multiforme brain cancer.

COURTESY MERIH DENIZ TORUNER

DETERMINATION:

Strengthening research methods through setbacks

Ashley Battenberg '21 lost months of in-person research time in the lab throughout the spring and summer of 2020. But this lost time actually strengthened her project, which investigated proteins that can contribute to age-related diseases and cancer.

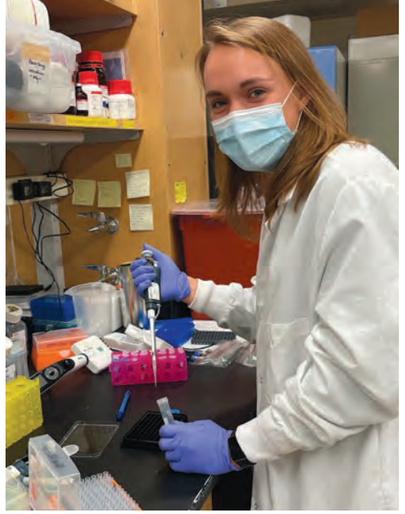
As part of her degree in biochemistry and molecular biology, Battenberg planned to be on campus working on the project during the summer between her junior and senior years, which wasn't possible during the pandemic. So instead of separating DNA fragments and studying them in Professor Gerwald Jogl's biology lab at Brown that summer, Battenberg was at home in Wisconsin, ▶

running computational models on her computer. What could have been a setback helped her work become more exact once she was able to return to the lab.

"The protein I'm looking at doesn't have clear start and stop sites. What I wanted to do in the lab was use that protein and see how it binds to DNA, but I was just going to guess the start and stop sites with trial and error," she said. "But with my computational methods, I used modeling software that predicted the start and stop sites for me. I did a bunch of research and computations on what the most likely start and stop sites were, and I used that information when I went back to the lab."

Her work won the Biology Senior Prize, and now she's a research assistant in the neurology department at Massachusetts General Hospital, studying chronic pain and amyotrophic lateral sclerosis (ALS), with plans to attend medical school down the road.

"In research, you always have to be prepared," she said, "because you never know the next method you're going to use or the next question you're going to have to ask."

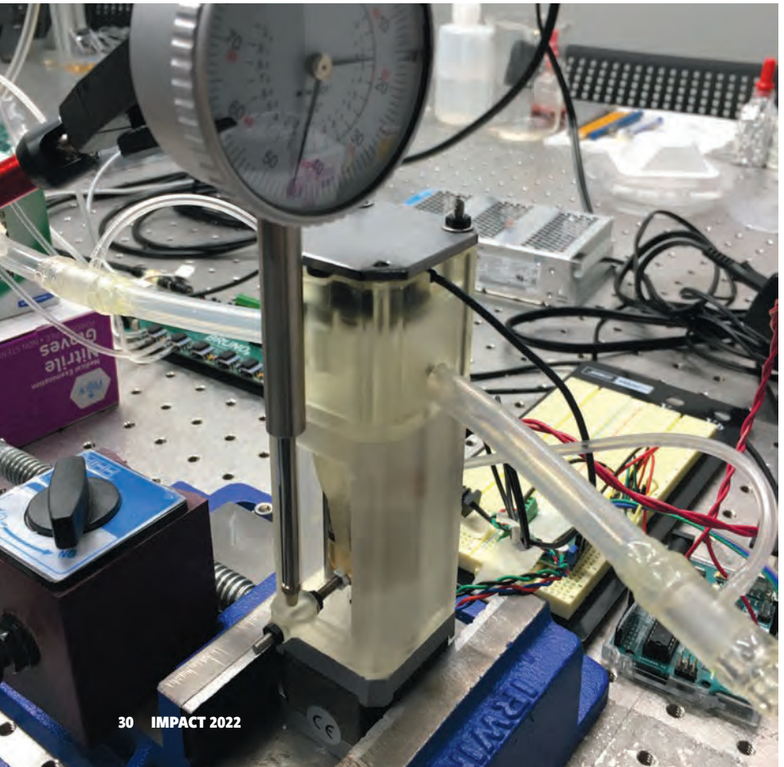


Ashley Battenberg '21 altered her project investigating proteins that can contribute to age-related diseases and cancer and earned the Biology Senior Prize for her work.

John Antolik '20 helped design a ventilator utilizing valves created by a 3D printer in response to a shortage of ventilators in the early days of the pandemic. Below: Testing one of the 3D-printed valve prototypes.

INNOVATION:

Responding to scarcity with a 3D ventilator design



John Antolik '20 worked "pretty much nonstop" on an engineering project when Brown paused academic activity temporarily after the pandemic's full arrival in March 2020. The project was a ventilator design made with valves created on a three-dimensional printer, since ventilators and the parts needed to build them were in short supply at the beginning of the pandemic.

"We wanted to do our best to make something that can actually help make a difference," said Antolik, who graduated from Brown with a degree in mechanical engineering and is now pursuing his PhD in engineering at Brown, focusing on fluids and thermal sciences. "It was seeing everyone else in the group working so hard and being inspired by them to go the extra mile."

The group, which began the work as part of a contest soliciting designs for low-cost ventilators, included several other undergraduate students as well as engineering faculty Roberto Zenit and Daniel Harris. After the contest, they merged their efforts with researchers at Stanford and the University of Utah to continue the project.

"From the very beginning, we were focused on this open source or open hardware idea, which would mean releasing all the designs, making them publicly available so anyone could build this," Antolik said. "I was really excited when I saw the level of collaboration happening, what a fast-paced project it was, and how quickly we were going through different ideas and testing them out and making progress towards something that would work."

In the end, their design was brought to life by scientists in Kenya, who got it approved by their local regulatory organization and are now using it for Kenyan patients. It was the first ventilator of its kind approved on the continent of Africa, according to Zenit.

"I've never seen anything like this, where different academic labs and industry partners work together and share everything," Antolik said. "We're sharing all kinds of information about ventilator design and combining the innovation of the academic groups with the experience of the industry partners. It was amazing seeing how far we got in such a short time."

"The ventilator project is a very good example of the Brown spirit," said Zenit. "We don't necessarily want to sit out and wait for a storm to pass—we are engineers, we are surrounded by talented people, especially our students. The intellectual part of Brown is there and ready to react under any circumstances. In these emergency conditions we are still facing, just give us some resources and we'll make good, amazing things for everybody."

COURTESY JOHN ANTOLIK '20; COURTESY ASHLEY BATTENBERG '21

COURTESY ELLA SATISH '20

Ella Satish '20 worked at RIDOH, leading the cash assistance and emergency food programs created with federal coronavirus funding.

DEDICATION:

Providing essential services and pandemic relief

At 22 years old and just a few months removed from her Brown graduation, **Ella Satish '20** led the Rhode Island Department of Health (RIDOH) rollout of a $1.3 million cash assistance and emergency food assistance program for Rhode Island families in need.

Satish had intended to spend the 2020–2021 academic year on a Fulbright English Teaching Assistantship in Colombia, but she wasn't able to travel there because of the pandemic. A student in the PLME program, she had already deferred her start date at Brown's medical school for the Fulbright and needed to make a new plan for her gap year before med school. She landed at RIDOH, working on their COVID-19 quarantine and isolation support team.

"The state gave us all the money but did not give us a plan or a structure, so it was up to me and my team," said Satish, who also collaborated with the leaders of the state COVID-19 response unit and the Health Equity Institute on the rollout. "We put together a method on how to screen people. We had two weeks to put it together, so it was definitely a challenge and a collaborative effort."

She found that her research experience as a Latin American and Caribbean Studies major prepared her for the work; for her senior thesis, she had analyzed the maternal child care program in Cuba as a model for improving outcomes and reducing disparities in care for Black mothers in the U.S.

"With the thesis and other research I had done, there's a lot of big planning stuff, because you have this monumental task ahead of you, which is to write a 90-page thesis or create a publication or do a presentation. I think it was a similar experience with the health department, even though it was a time crunch," Satish said. "Doing that sort of planning for a task so big was definitely something that had started with my undergraduate research and came to fruition working with the health department."

And while Satish ultimately wasn't able to have her planned Fulbright experience, her work at RIDOH provided essential services to the Rhode Island community. The food assistance program was able to deliver meals to families on the same day their help was requested. ■

Ashish K. Jha, dean of Brown's School of Public Health, talks about the crucial lessons of the pandemic

Teachable Moment

BY CORRIE PIKUL, ANDREW ILIFF

NICK DENTAMARO/BROWN UNIVERSITY

"Ashish has become a trusted voice of reason on the pandemic—helping to break down misinformation about how the virus spreads and the safety and efficacy of vaccines—and he's done this in a really savvy and incredibly informed but very down-to-earth way that exemplifies how public health communication has to happen if we're really going to make a dent in health behaviors and health policy."

— BROWN UNIVERSITY PRESIDENT CHRISTINA H. PAXSON

Disclosure: At the time of this interview, Dr. Jha was the dean of the Brown University School of Public Health. He is currently the White House COVID-19 response coordinator and counselor to President Biden. The views represented in this article are his own.

DR. ASHISH K. JHA WAS APPOINTED DEAN of the Brown University School of Public Health in February 2020, just as the COVID-19 pandemic was emerging. The virus—the greatest public health threat in a century—remains an ongoing theme of his tenure. He is working with the Brown public health community to understand the pandemic's impact on local, national, and global populations and is positioning the School of Public Health to foster health systems and public health responses that, as he says, "work better for all."

In March 2022, Jha was selected by U.S. President Joe Biden for a short-term special assignment as the next White House coronavirus response coordinator. In this role, Jha performs a critical service advising President Biden and leading the nation's pandemic response.

"Ashish will bring to President Biden and our nation what he has successfully brought—and will bring back—to Brown: an unrivaled commitment to improving public health equitably, effectively, creatively, with heart and a commitment to science," said President Christina H. Paxson. "The work he has begun at the School of Public Health will continue with the strong team he has recruited and the full support of the University. And it will advance even further with the benefit of this experience in national and global leadership."

In an interview prior to the news of this temporary role for Jha, he spoke about how public health research continues to grow at the University, springboarding from the demands of the pandemic to tackle the big challenges facing human health.

Q. In your State of the School Address, you talked about how America doesn't have the public health system we need, and certainly doesn't have the public health system we deserve. What did you mean by that?

Let's face it: our public health system largely failed during this pandemic. Building new public health systems and

more effective health policies requires very different ways of thinking about what goes into them, how you meet the challenges, and what kinds of investments are necessary. One of the ways we're trying to address that is by recruiting new faculty who have been working and thinking about these issues from different perspectives. But we can't do it alone. We need to enlist strong partners both across the University and the state, from the Watson Institute to the Rhode Island Department of Health.

Q. How can the School of Public Health and Brown University "move the needle" in improving public health?
One of the great things about working in public health is the natural collaborations that take shape when you take on the big health challenges. To understand the health consequences of climate change, public health scientists need to work closely with climate scientists; to understand how to mitigate the climate impact of the health sector, we need to work closely with people who understand energy policy.

Those of us working at the School of Public Health can have the biggest impact on actual health by partnering with colleagues, and I came to Brown because, in addition to our academic excellence, collaboration is part of the University's DNA. To give just one example, the pandemic has turned a spotlight on the immense racial disparities in health in our country; as we think about how to start to close some of these gaps, I'm thrilled to be able to partner with the University's Center for the Study of Race and Ethnicity in America.

Q. How did the School and its faculty adapt to the pandemic's disruptive impact on public health research?
Many researchers shifted their focus to the pandemic, which of course makes sense given that this is the most pressing public health issue of the last century. There are now faculty doing prediction modeling for the state of Rhode Island and looking at infection spread across the state, which has been helpful for local leaders. Vince Mor, professor of health services, policy, and practice, has done critical work on long-term care, and during the pandemic he has led important studies that examine how COVID-19 is affecting elderly people and those in nursing homes.

The Health Equity Scholars during orientation for the Master of Public Health program (l-r): Shaunessey Burks, Katia Jackson, Levell Williams, Meagan Ford, Khiara Lee, Abednego Comey, Malek Mitchell, Kayla Kinsler, Kristen Smith, Justin Coleman, Jalisa Stanislaus, Kristopher Britton, and Cedonia Thomas.

KENNETH C. ZIRKEL

BRINGING HEALTH EQUITY SCHOLARS TO BROWN

To confront systemic racism and health inequities, we must change the face of public health and train a new generation of diverse leaders. The Health Equity Scholars (HES) program provides a unique opportunity to applicants to Brown's Master of Public Health program from historically Black colleges and universities who have demonstrated leadership potential and are committed to addressing health inequities. In the 2022 academic year, HES is expanding to include students from Hispanic-serving institutions who are interested in addressing health disparities in Latino and Hispanic communities. HES will create a broad, interconnected network of transformational leaders centering equity and justice in their work in public health.

"...To me, health inequities and disparities are not simply interesting points that we need to pay attention to moving forward. They are the central organizing principles of our school." — DEAN ASHISH K. JHA

Then there are examples of brand-new projects, including our Global Epidemics website and risk-level dashboards that have been consulted by people around the world. And there are researchers who have recently joined Brown and are focusing on the pandemic—for example, Alyssa Bilinski, assistant professor of health services, policy, and practice, who has been looking at COVID-19 testing strategies to keep kids safe in schools.

Because of the volume and nature of this research, I would say that over the last two years, we've seen the Brown School of Public Health emerge as one of the leading institutions working on COVID-19. In the months to come, we will transition to managing the threat posed by this virus in a way that allows us to resume normal life, but we need to make sure we learn from this experience, both the mistakes and the things we did relatively well, like vaccine development. That's why we're leading a new effort for pandemic preparedness, to build and share the tools to help us weather the next outbreak.

Q. You've spoken about how COVID-19 has laid bare the deep racial inequities in our society. How can this lesson of the pandemic be applied to the way public health research is conducted at Brown?
To start, there is a very important new project looking at how to improve vaccine uptake in communities of color by engaging with community partners. That's being funded by the Rockefeller Foundation and is led by Stefanie Friedhoff, professor of the practice and senior director of strategy and innovation at the School of Public Health.

Then there are things we're doing from a leadership development point of view, like launching the Health Equity Scholars program, which provides MPH students from historically Black colleges and universities with the opportunity to address health disparities through research and practice while also gaining critical skills for leadership. I think that program is going to be key in bringing more diverse faculty into the school and addressing long-term issues.

It's really important that it be understood that to me, health inequities and disparities

Dean Ashish K. Jha, MD, MPH in front of the School of Public Health

NICK DENTAMARO/BROWN UNIVERSITY

Dean Ashish K. Jha presenting the State of the School Address for the School of Public Health, Sept. 1, 2021.

KENNETH C. ZIRKEL

are not simply interesting points that we need to pay attention to moving forward. They are *the* central organizing principles of our School. The awareness of these issues will inform the broader strategy for public health over the next decade. The fact is that we simply have to deal with deep inequities in our society and the way they manifest themselves in health crises like a pandemic.

Q. During the pandemic, we saw that the truth wasn't always as powerful as expected—that sharing health facts and explaining science sometimes failed as a way to connect and communicate with groups of people, leaving them vulnerable to dangerous misinformation. What is the School doing to combat this epidemic of misunderstanding?

We've launched a new initiative looking at the impact of misinformation and what to do about it. Misinformation is a global phenomenon, so one of the key questions is why Americans have been so much more vulnerable to it than some of our peers in other countries. We're looking at the spread of mistruths and unfounded facts through the lens of science to understand the underlying factors driving the spread of misinformation and the reasons why some points stick while others do not. And of course, we need to find out what can be done to counteract these dangerous processes—what types of interventions, one could say, can be applied to stop the spread of untruths.

Q. You have said that harnessing the data revolution would be one of your first priorities, and data continues to be a key challenge during the pandemic. What are the next steps?

This is a big challenge. There are some relatively straightforward fixes, and some areas where public health still has a lot of work to do. We've launched a new search for a senior professor of data science to help lead a new School-wide initiative on data science. One of the first orders of business for the initiative will be to pull together the various data assets and begin to develop new methods for how to analyze that data. This is just getting going.

Q. Beyond harnessing and analyzing data, how is the School changing the way research is conducted?

We've learned that giant, complicated problems like pandemics require the combined efforts of people working across departments, across the School, and across the University.

Right now, the research infrastructure of the University really sits within the individual centers. So we have been doing a lot of work to think about how we set up our research infrastructure to create incentives for more cross-school collaboration.

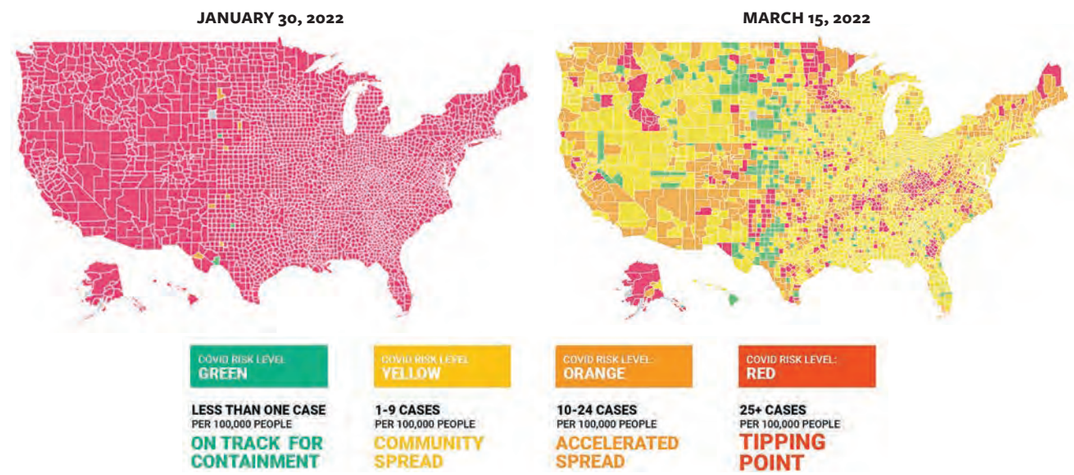
We're doing this with an eye toward understanding that the most important work of the next decade is going to be done in large teams of people that are truly multidisciplinary. You know, the National Institutes of Health recently came out with a strategic plan for funding research, and it emphasized cross-disciplinary work—which, of course, is Brown's well-known strength.

On top of that, we're bringing in scholars outside of the traditional field of public health to help us think about some complex public health challenges from different points of view.

I believe that the next few months and even years are going to be a very exciting time for public health research, especially at Brown. Perhaps this will be a small glimmer of a silver lining from the past two years. ■

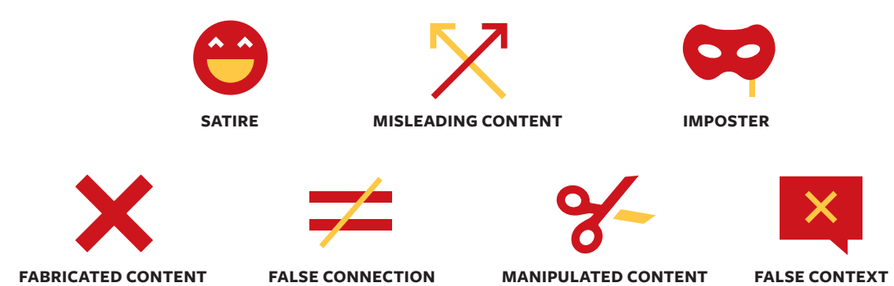
PROVIDING ACTIONABLE KNOWLEDGE ON GLOBAL EPIDEMICS

How can universities support public understanding of shifting evidence during a pandemic and curate data and insights to provide actionable knowledge? Since the early days of COVID-19, the pandemics team in the Brown University School of Public Health has delivered key science translation and communications projects on its GlobalEpidemics.org website, helping Americans understand concepts such as hospital capacity, the need for testing, and COVID-19 risk levels through an interactive county-by-county map. The site attracts millions of visitors from around the world.



"Many researchers shifted their focus to the pandemic...because of the volume and nature of this research, I would say that over the last two years, we've seen the Brown School of Public Health emerge as one of the leading institutions working on COVID-19." — DEAN ASHISH K. JHA

7 TYPES OF MISINFORMATION



DECIPHERING MISINFORMATION

Health misinformation threatens to undo major achievements in public health; it harms individuals, communities, economies, and democracies. The Brown School of Public Health is launching a major new initiative to study and counteract misinformation by evaluating strategies that inoculate people against low-quality information and helping people recognize the different forms misinformation can take.

FOCUS

A CLOSER LOOK AT RESEARCHERS AND PROJECTS GAINING WIDER INFLUENCE

Lorin Crawford, assistant professor of biostatistics

KINDRA CLINEFF

NICK DENTAMARO/BROWN UNIVERSITY

Unraveling DNA with Machine Learning

Lauded biostatistician takes an interdisciplinary approach to understand gene interactions. BY LI GOLDSTEIN '22

IT'S NEARLY IMPOSSIBLE to categorize Lorin Crawford's research into a single discipline. Crawford, RGSS Assistant Professor of Biostatistics, is equally fluent in genomics, physics, machine learning, and pure math, and his various realms of expertise blend in harmony to produce novel research about nonlinear interactions between genes. By constructing nuanced machine learning algorithms and running them on genomic datasets, Crawford is tackling how gene interactions contribute to trait architecture and disease etiology.

In practice, Crawford's research falls into three buckets.

The first involves sourcing datasets from consortia that have taken DNA samples from upward of 100,000 individuals and building algorithmic models to understand how certain traits might arise from one gene's interaction with another. His algorithms can forecast trait expression, from BMI and height to gene dysregulation that might lead to an unhealthy tumor. Using the output of this research, Crawford and his team recommend targeted treatment strategies founded on a more robust understanding of how a set of genes additively give rise to a particular disease.

In the second, Crawford applies a similar methodology to cancer genomics research, in which he and his team study the roots of tumor resistance in order to increase drug effectiveness.

Imaging, the third bucket of his research, is another tool for refining targeted therapy, by visualizing tumor structure to understand the mechanisms that cause it to proliferate. "If I took an image of a brain tumor from an MRI scan," Crawford proposed, "does that hold information about the biological processes that created this structure that's contributing to the sickness of this patient?"

"Maybe I could look at a brain tumor and say, 'Okay, this is a weird morphological signature that looks like other brain tumors we've seen, and I know that other patients were better treated with this treatment type,'" he said. "So, by that similarity, maybe I should try that treatment strategy on this person as well."

Crawford's lab has recently created synthetic tumor models from tissue taken from actual tumor patients and hopes to publish a paper soon on their findings. This method of modeling allows researchers to reproduce tumor structures and mechanisms *ex vivo*, without testing on a tumor in a live patient but instead on a synthetic model.

The potential implications and applications of his research are vast and have been validated in published papers, such as one detailing drug combination therapies to target treatment-resistant melanoma.

Crawford works collaboratively with researchers at Brown and at the Broad Institute of MIT and Harvard to put his findings into practice in clinical settings. He characterizes this symbiotic working relationship as an end-to-end pipeline in which he strives "to build models that better form both the data that they've already generated but also maybe potentially give them some kind of insights, new data that might be helpful in finding new discoveries."

Crawford has a faculty appointment in the Brown School of Public Health with an affiliation in the Center for Computational Molecular Biology. He is also a senior researcher at Microsoft Research New England. At age 30, Crawford has been honored with a Sloan Fellowship, a Packard Fellowship, a spot in the listing of The Root 100 list of the most influential African Americans in any field, and a place on *Forbes*'s 30 Under 30 list. ►

"The validation from the Sloan Foundation springboarded me to be in spaces and conversations with people that I probably would not have been in before" through its extensive network of collaborators, Crawford said.

The Packard Foundation also offers Crawford invaluable network access, alongside more tangible benefits such as curated datasets and money to hire personnel and purchase computing resources. "It puts you in the room with Nobel Prize–winning people," he said. "It's an incredible network."

Underlying Crawford's research approach is an acute awareness of who it serves and reflects and who it omits. Predictive modeling is limited in its ability to generalize with precision across ancestral groups, he explains, but this limitation has motivated him to investigate how to nuance his algorithms to address these discrepancies.

"Predatory inclusion is including people in your study for the sake of including them, without really being able to do something useful for that community." — LORIN CRAWFORD

Alongside confronting the homogeneity embedded in available datasets—which often disproportionately reflect patients of self-identified European ancestry—Crawford believes that more complex modeling can begin to rectify the inequities embedded in this type of research and expand the range of patients who will benefit from its findings. He's cognizant of the trend of "predatory inclusion," he said, which he defines as the practice of "including people in your study for the sake of including them, without really being able to do something useful for that community."

"The goal is precision medicine for everyone," he said, with a concerted effort to "fight low sample sizes in machine learning statistics." ■

Schools' COVID-19 Questions, Answered

The Annenberg Institute for School Reform responds to educator concerns during the pandemic.

BY OLIVIA BURDETTE '22.5

Nate Schwartz, associate professor of the practice at Annenberg Institute for School Reform

COURTESY NATE SCHWARTZ

THE COVID-19 PANDEMIC HIT Coventry Public Schools in Coventry, Rhode Island, as it did every other educational institution in the country: like a ton of bricks.

In March 2020, the virus sent everyone home for the rest of the school year, and the new school year in the fall didn't look much sunnier. Coventry superintendent Craig Levis, like many others in his position, found himself in charge of a district that needed to make up for lost time while supporting its community through a time of overwhelming grief.

Levis knew that classes would need to resume as usual to keep lesson plans on track through the 180 school days, but he also knew that something else needed to be addressed first: the well-being of the teachers and staff in his district.

"When we were talking about COVID's impact, the big thing was around learning loss," Levis said. "I see all this work that we're going to cover over the next few weeks and months, but we do that through people. And if we don't take care of those people and acknowledge the fact that they're struggling, this all could be for naught."

Levis brought this up at one of his district's first meetings with representatives from EdResearch for Recovery, a new program spearheaded by Brown's Annenberg Institute for School Reform in partnership with the policy group Results for America.

The program began in July 2020 when education experts at Annenberg realized that they needed to pivot their work with local school districts that were struggling in the throes of a pandemic.

"We got into a conversation with some district leaders around the state and asked what type of partnership might actually be most useful from Annenberg during this moment in time," said program founder Nate Schwartz, associate professor of the practice at Annenberg.

District leaders said most of their time was consumed with operational questions on ventilation and masking when they knew they needed to spend more time on the unfolding educational crisis. Students' mental health was suffering and many weren't making academic progress.

While the specifics of the pandemic were unprecedented, insights from decades of research by national experts could be applied to help schools address these issues. The Annenberg researchers collected and organized dozens of questions from local district leaders. Soon they began to think about a model in which education experts were asked not only about their research but also about their informed opinions on how to address schools' most urgent needs.

"It's sort of taking researchers out of what is often a somewhat more neutral stance and asking them to lay concrete bets," Schwartz explained. "We asked researchers, if you had to put your money where your mouth is right now, what would you do and why?"

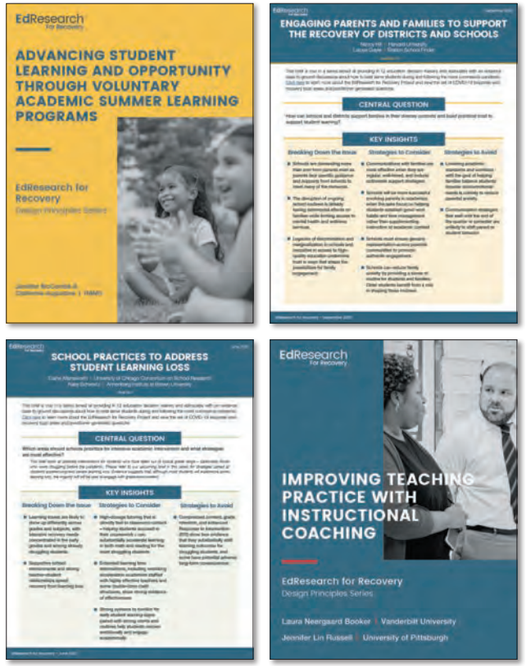
These questions led to a series of research briefs on everything from implementing tutoring programs to combating learning loss to rebuilding a positive school climate. They are short, easy to read, and get directly to the point of how to effectively implement evidence-based strategies in schools.

Since Schwartz doesn't believe that "research briefs, in and of themselves, change the world," the program also allows district leaders a venue for engaging directly with researchers and piloting the strategies laid out in the research briefs. The EdResearch for Recovery team met with a network of school districts in Rhode Island, including the one in Coventry, to assess their specific needs and advise them on implementing strategies.

Working with Levis, the team recommended research-based interventions that supported teachers and staff as they navigated working with students while dealing with turmoil in their own lives. Addressing teacher wellness wasn't at the top of the list of priorities from the beginning, but after Levis brought it up, "they made it part of their agenda early on," he said, "because we needed to talk about this before we could work on the academic interventions."

Superintendent Levis said that working with EdResearch for Recovery has been one of the most powerful experiences he's had as an educator.

Annenberg director Susanna Loeb said that EdResearch for Recovery is a perfect representation of what Annenberg does. "We think very much about the process of taking the research and the knowledge we create and making it actionable," she said. "In EdResearch for Recovery, it worked so well because we had the sourcing of questions from school leaders around the country, and then we used these connections to researchers and scholars to get answers to those questions and put them in the form of a tool that summarizes what one could do to address them."



"We asked researchers, if you had to put your money where your mouth is right now, what would you do and why?" — NATE SCHWARTZ

The ongoing pandemic remains a challenging environment for teaching and learning, and questions continue to arise from school leaders. In January, EdResearch for Recovery released briefs on strengthening school counseling programs and building effective instructional coaches—and also held a workshop for Rhode Island districts and community-based organizations aimed at ensuring summer enrichment programs for students align with the best available evidence.

EdResearch for Recovery continues to represent a real-time, need-based model for bringing knowledge directly to school leaders in a way that helps them keep teaching, learning from, and supporting one another. ■

Breaking Free with the Arts

Expressive arts help those with neurological disorders defy the limits of mind and body. BY SHERRI MILES

"A DANCE IS A STORY," said Julie Adams Strandberg, distinguished senior lecturer in the dance program of the Department of Theatre Arts and Performance Studies at Brown. "It has to be passed on."

The stories told on the stage of the Ashamu Dance Studio during the Artists and Scientists as Partners (ASaP) symposiums are about grace, as dancers—both seated and on foot—perform rhythmic, swaying movements to a piece of repertory. The dance is a shared story among a multi-generational cast of dancers from Brown Dance Extension, Dancing Legacy, Central Falls High School, and Dance for All People (DAPpers), which offers classes for those with Parkinson's disease and other movement challenges.

For the DAPpers participants, the story is also about building identity as dancers rather than as Parkinson's patients and reconnecting with their bodies in welcome new ways as they perform repertory etudes adapted for a more limited range of movement.

"With Parkinson's, everyone is always telling you what you can't do, and your world shrinks," said Steve, who was diagnosed with Parkinson's in 2008. "But coming to this dance class and symposium and learning the etudes expands your horizon a little bit again. The doctors took care of me medically, but there are so many other aspects of my personality that weren't being addressed."

Depression among the elderly is often overlooked. People with Parkinson's may feel a sense of isolation and end up living in an inner world with an uncooperative body and inability to communicate. Autism often shares these characteristics. Expressive arts, such as dance, theatre, and singing, can enable people with these disorders to find joy, connection, and longed-for freedom of movement.

Strandberg and a former student, Rachel Balaban '80, a certified instructor in the Mark Morris Dance Group's Dance for PD® program, co-founded ASaP in 2013 to offer an expressive arts program at Brown for people with Parkinson's disease and those with autism spectrum disorder. "My whole career is about making dance accessible to everyone," said Strandberg. "The goal was to really empower everybody to have this experience."

The ASaP program encompasses symposiums, interdisciplinary research, and community engagement projects. The research and projects feed and support a two-semester undergraduate course sequence—*Arts and Health: Theory* and *Arts and Health: Practice*. Students learn the neuroscience of Parkinson's disease and autism spectrum disorder, conduct empathy interviews to understand the lives beyond the medical diagnosis, and participate in an eight-week site placement with either DAPpers or The Miracle Project.

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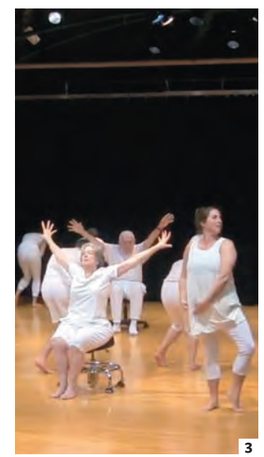


1. Artists and Scientists as Partners (ASaP) pioneers interdisciplinary research and accessible art programs to holistically address medical and social issues.
2. Rachel Balaban '80, ASaP codirector and movement director for The Miracle Project New England, helps summer campers rehearse for a showcase performance.
3. DAPpers perform Danny Grossman's Ecce Etude with students and professional dancers at the 2018 ASaP Symposium in Brown's Ashamu Dance Studio.
4. Julie Adams Strandberg, distinguished senior lecturer in Theatre Arts and Performance Studies, receives the Susan Colver Rosenberger Medal of Honor on May 6, 2021.

BROWN UNIVERSITY; NICK DENTAMARO/BROWN UNIVERSITY

> **"The people in DAPpers and The Miracle Project feel like they belong somewhere, and that what they think and feel matters."** — JULIE STRANDBERG

The Los Angeles–based Miracle Project uses music, movement, theatre, and film to enter into the worlds of children and young adults with autism and related disorders. Since 2004, The Miracle Project has produced many success stories and has been the subject of two HBO documentary films. New national and international locations have opened, including the Brown-based Miracle Project New England, where students train as counselors.

"The kids with autism are finding this community that they can feel connected to," said Strandberg. "Autism, by definition, means self, auto. Many people on the spectrum say, 'I don't want to be isolated. I just don't know how to communicate.'"

"At the beginning, we didn't see anything similar between autism and Parkinson's," said Strandberg, "but when we started working with the two groups, a lot of similarities began to emerge. The people in DAPpers and The Miracle Project feel like they belong somewhere, and that what they think and feel matters. They're not criticized, and they're not thought of as their illness."

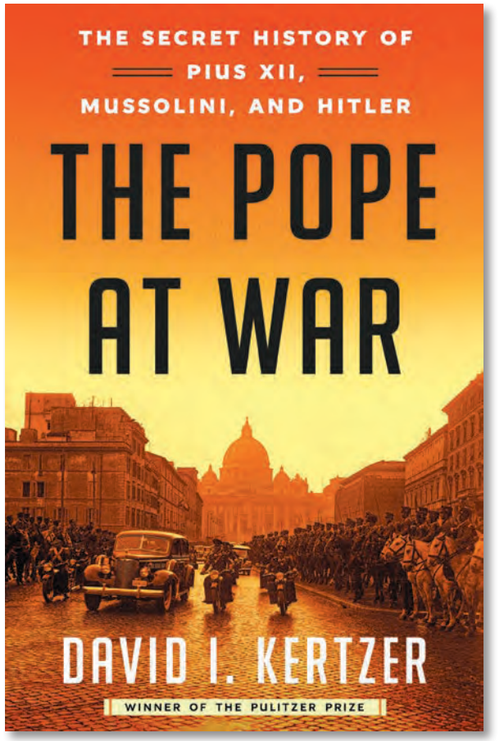
"The work I'm doing now with Artists and Scientists as Partners is helping to figure out how to put the humanity back into the medical profession," said Strandberg. "And part of doing that is really looking at the arts in and of themselves as valuable in terms of healing."

Strandberg has taught thousands of dancers during her 50-year career at Brown. In 2021 she received the rarely awarded Susan Colver Rosenberger Medal of Honor from Brown faculty for her pivotal role in elevating the arts at Brown, for her work as the founder and cultivator of the dance program, and for her empathy.

She sees more opportunities ahead. "We study books, we study literature. That's what a dance is. The dance is an individual artist's perspective on their time and on an idea or an experience," she said. "I want to do more to make sure that access to these stories belongs to everybody, just like other literature. Once you stop telling a story, it has passed." ■

A Pope's Story Revealed

Using newly unsealed archives of Pius XII, Professor David Kertzer takes a fresh lens to a pope at war. BY LI GOLDSTEIN '22



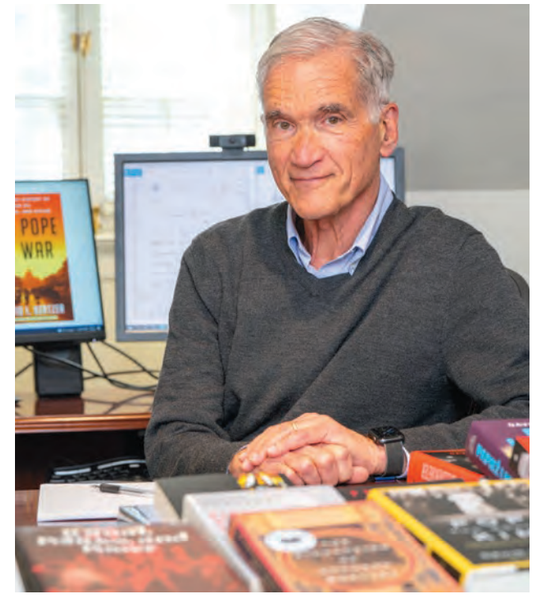
ACADEMICS WHO STUDY church-state relations in Italy often fall into two camps, according to David Kertzer, the Paul R. Dupee, Jr. University Professor of Social Science and a preeminent expert on the history of Vatican relations with Italian politics. The first camp—the church historians—pore over archives from the Roman Catholic Church and tend not to work in civil archives. Secular historians, by contrast, conduct their research in state archives through a more distinctly political lens.

Kertzer's research sits at the intersection of the two. The overlapping space in the Venn diagram of church history and secular history is a site of rich and nuanced analysis. And the two are inextricable, Kertzer says. The decision-making of church actors—namely, the pope and his clergy—can't be fully understood without consideration of their relationship to and communications with state actors. Kertzer and his research team have most recently delved into the controversial question of Pius XII during World War II, specifically tackling his failure to publicly condemn the Holocaust, a decision drawing widespread criticism.

"My task is triangulating documents from different archives around the same events, the same dates, to better understand what actually is going on," Kertzer said. "Whereas if you just base your work on, say, church archives or just base it on a set of state archives, you tend to get a limited, blinkered view."

His research relies heavily on the long-awaited and eagerly anticipated opening of the papal archives for Pius XII, containing thousands upon thousands of newly unsealed documents chronicling his communications with stakeholders inside and outside of the church. Kertzer, winner of the 2015 Pulitzer Prize for his book *The Pope and Mussolini: The Secret History of Pius XI and the Rise of Fascism in Europe*, was one of the few scholars present in those archives the first day they were open in March 2020, before they closed in response to Italy's COVID-19 lockdown. The archives have since reopened with limited visitation.

The barrier to securing access to documents, for many researchers, is the cost of copying them, which can be as much as $10 per page. Enabled by a generous research fund from Brown, Kertzer has secured over 7,000 pages of archival documents. "I'm not aware of any scholar who has been able to obtain nearly as much material from those archives," he said.



David Kertzer, professor of social science, anthropology and Italian studies

KINDRA CLINEFF

"I thought a lot of these debates lacked nuance, and they didn't really give us an understanding of what was going through the pope's mind during the war."

— DAVID KERTZER

The findings, Kertzer says, are "explosive"—though he can't share them publicly until the release of his book, *The Pope at War*, to be published in June by Random House in the United States and by Garzanti in October in Italy.

Internal memos between Pius XII and trusted aides, illuminating the pope's own thoughts and reservations, add texture to a debate that Kertzer says often glosses over complexities. "He's a great hero of conservatives in the church, who portray him as a great antagonist of fascism and of Nazism and a great defender of Jews," he said. "His critics accuse him of cowardice and antisemitism."

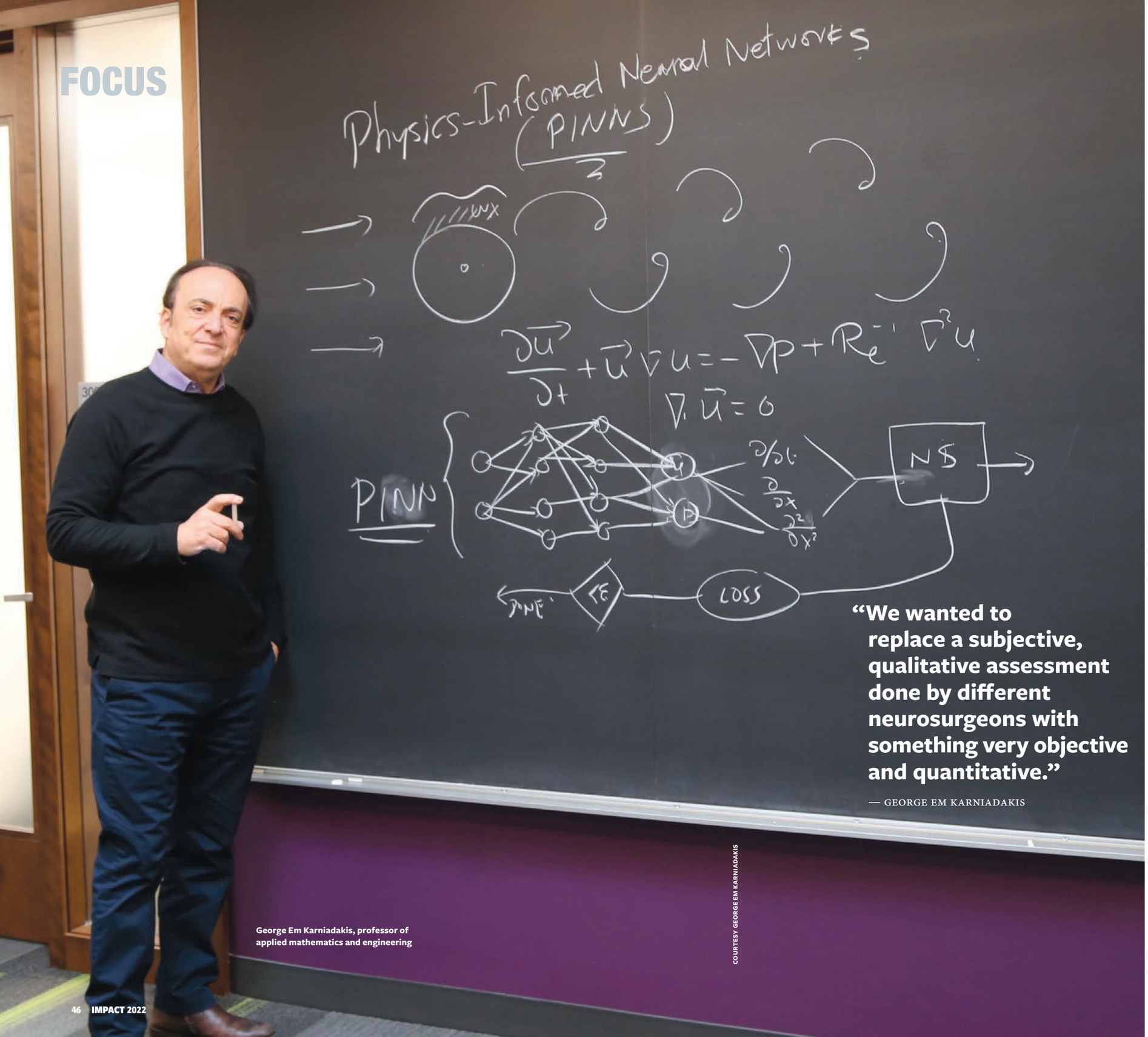
"I thought a lot of these debates lacked nuance, and they didn't really give us an understanding of what was going through the pope's mind during the war," Kertzer said.

What was going through Pius XII's mind, Kertzer argues, was how best to protect the church in the face of political turmoil. "He had good reason to believe Hitler was going to win the war—most people thought Hitler was going to win the war in the early years," he said. "And so a lot of his actions had to do with this notion of protecting the institutional church in Europe that could well be ruled by Hitler and … Mussolini." Memos reveal, too, the antisemitism that "surrounded" Pius XII in his aides and trusted advisors.

But the Vatican archives alone don't paint a full picture. Anticipating that Pope Francis would eventually unseal Pius XII's archives—the public pressure to do so, he says, has only grown since the 1960s—Kertzer has plumbed various state archives with respect to Pius XII's papacy. His work in the state archives of Italy, the United States, France, Germany, and Britain laid the groundwork for his later research and propelled his book-writing process, positioning him to be able to schedule a release for June 2022.

Such archives contain reports from those meeting regularly with the pope and his closest advisors in their capacity as state ambassadors or as envoys to the Vatican, capturing candid impressions of his papacy absent from official church archives.

Kertzer maintains a 4,000-page indexed catalog of his research organized by date, allowing him to access and cross-reference archival material from both state and Vatican archives all in one place. In triangulating the distinct narratives contained in each archive, Kertzer hopes to animate a character mired in controversy but often lacking sufficient dimension in portrayals of him—aiming not to excuse Pius XII's silence amidst the Holocaust, but to contextualize it. ■



George Em Karniadakis, professor of applied mathematics and engineering

COURTESY GEORGE EM KARNIADAKIS

New Artificial Intelligence Detects Danger in Blood Vessels

Neural networks use physics and math to predict ruptures in aneurysms.

BY KATHLEEN MEININGER '23

THROUGHOUT HIS RESEARCH CAREER, George Karniadakis, the Charles Pitts Robinson and John Palmer Barstow Professor of Applied Mathematics and Engineering, has pioneered diverse computational methods for multiscale problems in science and engineering. More recently, riding the artificial intelligence (AI) wave of the last decade, his team has introduced the use of physics-informed neural networks to diagnose the severity of arterial aneurysms.

Aneurysms are bulges in the arteries caused by blood pressure pushing a weakened section of the arterial wall outward. Over time, arterial blood flow can lead to increased pressure on these sack-like structures, leading to their growth, weakening, and eventual rupture.

Karniadakis's lab uses computational biology to model biological processes. His work on aneurysms began 15 years ago when he partnered with Joseph Madsen, a pediatric neurosurgeon at Boston Children's Hospital, and the late Peter Richardson, a professor of engineering at Brown.

Although aneurysms can occur anywhere in the body, one of the most common locations is the brain. Rupture can cause massive stroke and nearly half the time leads to death, according to the Brain Aneurysm Foundation. However, brain surgery to remove the aneurysm is inherently risky and can itself result in brain damage or stroke. For this reason, physicians only operate on high-risk aneurysms.

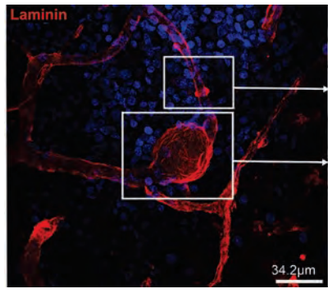
A major issue neurosurgeons face is determining if and when to operate, Karniadakis said. Using X-ray and MRI techniques, "doctors simply look at the aneurysm with the naked eye and say 'Oh, that doesn't look good, I better operate," he explained. "It's totally qualitative. We wanted to replace a subjective, qualitative assessment done by different neurosurgeons with something very objective and quantitative."

The researchers focused on the circle of Willis, a ring of blood vessels connecting the four major arteries of the brain that is particularly susceptible to aneurysm formation. They devised a way to use neural networks, which are a type of AI that consists of thousands of processing nodes ►

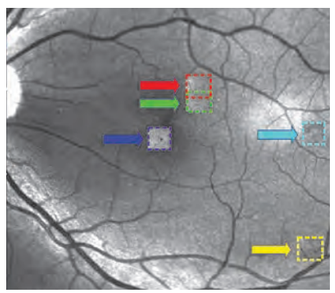
> **"We wanted to replace a subjective, qualitative assessment done by different neurosurgeons with something very objective and quantitative."**
>
> — GEORGE EM KARNIADAKIS

designed to mimic neurons in the human brain, informed by mathematical equations that describe blood flow to predict aneurysm rupture.

Using visual data from MRI scans to construct the geometry of the aneurysm, and video of flow visualization with contrast agent that the doctor injects into the patient, the neural networks computed blood flow and pressure and inserted these values into a physics equation governing fluid dynamics. If the equation result didn't match these calculations, the "neurons" were able to "learn" and modify their result until they determined correct flow and pressure values. The researchers termed this system physics-informed neural networks (PINNs).



Small microaneurysm (upper box) and large microaneurysm (lower box)



Retinal microaneurysms are an early feature of diabetic retinopathy, manifested as small, dark red spots.

JOSLIN DIABETES CENTER; INVESTIGATIVE OPHTHALMOLOGY & VISUAL SCIENCE FEBRUARY 2017, VOL.58, 1116–1131

"Physics-informed neural networks (PINNs) are a way to bring physics and mathematics into the neural network," Karniadakis said. "We can zoom in on the aneurysmal sac where the problem is…and predict when the rupture will happen based on objective criteria."

Karniadakis's lab has recently collaborated with researchers from the Massachusetts Institute of Technology and Nanyang Technological University in Singapore, using PINNs to create an AI system that can identify and measure blood flow within retinal microaneurysms for diabetic retinopathy (DR). Karniadakis and his main Brown collaborator He Li, who is assistant professor of engineering at Brown's Center for Biomedical Engineering, also collaborate with Jennifer Sun and Konstantina Sampani from Harvard's Joslin Diabetes Center.

"The vessels are very small, but if the (aneurysms) dilate and then rupture, the patient will be blinded," Karniadakis said.

These microaneurysms—too small to be detected with the naked eye—occur in patients with diabetic retinopathy when uncontrolled blood sugars damage retinal blood vessels in the back of the eye. Because of their minuscule size, physicians face the additional challenge of detecting the microaneurysms before they can treat them.

"We're developing other neural networks to find the aneurysms and tell us their shapes, sizes, and what they look like," Karniadakis said.

The researchers created "microaneurysms-on-a-chip," microfluidic devices with bulges of different shapes and sizes that mimic microaneurysms. By practicing the analysis of fluid flow through these devices, the PINNs were trained to calculate the velocity of blood in real patient microaneurysms—valuable information physicians can use to judge risk of rupture. The results of this artificial intelligence velocimetry, or AIV, were published in the *Proceedings of the National Academy of Sciences*.

"We are trying to make this a product," Karniadakis said, adding that the researchers have been working with a company to get these PINNs on the market so that they can benefit patients suffering from aneurysms. Before they can do that, however, the product must go through clinical trials and then FDA approval.

Currently, Karniadakis and his team are working on developing new AI to identify these microaneurysms among what he calls the "forest of blood vessels" and classify their severity based on shape. They have developed the AOSLO-net, which can automatically identify and segment microaneurysms from images acquired with adaptive optics scanning laser ophthalmoscopy in Sun's lab at the Joslin Diabetes Center.

"Ultimately, the aim of the Brown-Harvard team is to develop a new integrated imaging and modeling framework using advanced AI models (such as AIV and AOSLO-net) that could facilitate the pathological study of diabetic retinopathy and help ophthalmologists make disease prognoses," said Karniadakis.

Success would help shift the paradigm from conventional DR screening approaches based on fundus images—pictures of the back of the eye taken with retinal cameras—to more advanced imaging modalities.

"This framework can potentially be extended to investigate critical hemodynamic markers for other cardio- and cerebrovascular diseases," said Karniadakis. ■

BROWN RESEARCH INDEX

With more than 700 regular faculty and hundreds more in clinical and other categories, Brown produces an enormous range and volume of research. The Brown Research Index captures some of this output through a list of faculty books published and honors received.

By the Book

In 2020, Brown professors published 90 books spanning many disciplines and subjects.

AMERICAN STUDIES

KEVIN ESCUDERO
- *Organizing While Undocumented: Immigrant Youth's Political Activism Under the Law*

SUSAN SMULYAN
- *Doing Public Humanities* (Editor)

SAMUEL ZIPP
- *The Idealist: Wendell Willkie's Wartime Quest to Build One World*

ANTHROPOLOGY

STEPHEN HOUSTON
- *The Adorned Body: Mapping Ancient Maya Dress* (Editor)

PATRICIA RUBERTONE
- *Native Providence: Memory, Community, and Survivance in the Northeast*

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- *Orazio: L'Arte Poetica* (Author of introduction)

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- *A Bibliography of the Works of Ian Jackson*

OURIDA MOSTEFAI
- *Silence, Implicite et Non-Dit chez Rousseau/Silence, the Implicit and the Unspoken in Rousseau* (Editor)

MARC REDFIELD
- *Shibboleth: Judges, Derrida, Celan*

PETER SZENDY
- *The Supermarket of Images* (Editor)

COMPUTER SCIENCE

MAURICE HERLIHY
- *The Art of Multiprocessor Programming, Second Edition*

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LIWEI JIAO
- *Chinese Religious, Political, and Philosophical Proverbs*

LINGZHEN WANG
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- *Ancient Egyptian Phonology*

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- *A Companion to African Literatures* (Editor)

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- *The Intimacies of Conflict: Cultural Memory and the Korean War*

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- *Phenomenology to the Letter: Husserl and Literature* (Editor)

GERHARD RICHTER
- *Literary Paternity, Literary Friendship: Essays in Honor of Stanley Corngold* (Editor)

THOMAS SCHESTAG
- *Francis Ponge, Le Soleil/Die Sonne* (Editor and translator)

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- *Middling Romanticism: Reading in the Gaps, from Kant to Ashbery*

INSTITUTE AT BROWN FOR ENVIRONMENT AND SOCIETY

LAURENCE SMITH
- *Rivers of Power: How a Natural Force Raised Kingdoms, Destroyed Civilizations, and Shapes Our World*

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- *The Nation and Its Ruins: Antiquity, Archaeology, and National Imagination in Greece* (Macedonian edition)

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TARA NUMMEDAL
- *Furnace and Fugue: A Digital Edition of Michael Maier's* Atalanta fugiens *(1618) with Scholarly Commentary* (Editor)

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- *America's History: Concise Edition*

VAZIRA ZAMINDAR
- *Love, War and Other Longings: Essays on Cinema in Pakistan* (Editor)

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DIETRICH NEUMANN
- *An Accidental Masterpiece: Mies van der Rohe's Barcelona Pavilion*
- *Mies van der Rohe Barcelona-Pavillon: Hundert Texte seit 1929/The Barcelona Pavilion by Mies van der Rohe: One Hundred Texts since 1929* (Editor and translator)
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ADAM TELLER
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THALIA FIELD
- *Leave to Remain: Legends of Janus*

SAWAKO NAKAYASU
- *Some Girls Walk Into the Country They Are From*
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- *Say Translation Is Art*
- *Yi Sang: Selected Works* (Translator)

COLE SWENSEN
- *Nativity by Jean Frémon* (Translator)

MEDICAL SCIENCE

CARSTEN EIKHOFF
- *Experimental IR Meets Multilinguality, Multimodality, and Interaction: 11th International Conference of the CLEF Association, CLEF 2020, Thessaloniki, Greece, September 22–25, 2020, Proceedings* (Editor)

ALBERT WOO
REENA BHATT
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GERRIT VAN SCHALKWYK
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TINA CAMPT
- *Imagining Everyday Life: Engagements with Vernacular Photography* (Editor)

ANTHONY COKES
- *If UR Reading This It's 2 Late: Vol. 1-3*

JOAN COPJEC
- *Umbr(a): A Journal of the Unconscious. Special issue on Writing* (Korean edition)

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PAUL GUYER
- *Reason and Experience in Mendelssohn and Kant*

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- *What Is Political Philosophy?*

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MARK BLYTH
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ETHAN MOITRA
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SIMIN LIU
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BESS MARCUS
- *Active Living Every Day*

IAN SALDANHA
- *Scanning for New Evidence on the Nutrient Content of Human Milk: A Process Model for Determining Age-Specific Nutrient Requirements*

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CHRISTOPHER SCHMID
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SVETLANA EVDOKIMOVA
- *Amplitudo Cordis*

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- *It Will Be Fun and Terrifying: Nationalism and Protest in Post-Soviet Russia*

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JOSE ITZIGSOHN
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REBECCA SCHNEIDER
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PETER ANDREAS
- *Killer High: A History of War in Six Drugs*

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- *Peacekeeping, Policing, and the Rule of Law after Civil War*

ERIC PATASHNIK
- *Unhealthy Politics: The Battle over Evidence-Based Medicine*
- *The Politics of the Opioid Epidemic (An issue of Journal of Health Politics, Policy and Law)* (Editor)
- *Dynamics of American Democracy: Partisan Polarization, Political Competition, and Government Performance* (Editor)

COMPILED BY CHANELLE DUPUIS, GRADUATE STUDENT FRENCH STUDIES PHD

Sources: Brown University Dean of the Faculty's Office, School of Public Health and Division of Biology and Medicine

BROWN RESEARCH INDEX

Selected Faculty Research Honors

During the 2020–2021 academic year, faculty won dozens of research honors from national and international organizations. This year also marks the fifth annual Research Achievement Awards program at Brown, honoring extraordinary scholars nominated across a wide range of academic disciplines. Awardees are selected from six categories by panels of distinguished Brown faculty. Winners are recognized at Brown's annual Celebration of Research and receive a $5,000 research stipend.

AHMED ABDELFATTAH
Robert J. and Nancy D. Carney University Assistant Professor of Neuroscience
- Research Fellowship, Searle Scholars Program

DAN ABRAMOVICH
L. Herbert Ballou University Professor of Mathematics
- Fellow, Simons Foundation

JASJIT SINGH AHLUWALIA
Professor of Behavioral and Social Sciences, Professor of Medicine
- Elected Member, 2021 Tobacco and Nicotine Products Committee, Food and Drug Law Institute

DOUGLAS ANTHONY
Professor of Pathology and Laboratory Medicine, Professor of Neurology
- Vice President-Elect, American Association of Neuropathologists

HERBERT ARONOW
Associate Professor of Medicine
- President-Elect, Society for Vascular Medicine

SARA BECKER
Associate Professor of Behavioral and Social Sciences, Associate Professor of Psychiatry and Human Behavior
- G. Alan Marlatt Midcareer Research Award, Association for Behavioral and Cognitive Therapies
- Dean's Award for Excellence in Research Collaboration, School of Public Health, Brown University

ROBERT BLAIR
Joukowsky Family Assistant Professor of Political Science and International and Public Affairs
- Brown Early Career Research Achievement Award

ANDREW CAMPBELL
Professor of Medical Science, Dean of the Graduate School
- Fellow, American Association for the Advancement of Science

LINDA L. CARPENTER
Professor of Psychiatry and Human Behavior
- President-Elect, Society for Biological Psychiatry

OU CHEN
Assistant Professor of Chemistry
- Brown Early Career Research Achievement Award

DAVID CHRISTENSEN
Professor of Philosophy
- Royce Family Professor of Teaching Excellence, 2018–2021
- Inaugural Ernest Sosa Prize Lecture, American Philosophical Association

PATRICIA CIOE
Associate Professor of Behavioral and Social Sciences
- URI Luminary in Nursing, University of Rhode Island College of Nursing

KINDRA CLINEFF

ROBERT BLAIR
Political science and international and public affairs
Early Career Research Achievement Award
Robert Blair studies how to restore political legitimacy and trust in governments after periods of civil disorder and governance failure. He has conducted security sector reform initiatives in Liberia, Uganda, and Colombia; published his first book, *Peacekeeping, Policing, and the Rule of Law after Civil War*; and led the development of Democratic Erosion, a consortium involving more than 50 universities worldwide that uses research, teaching, and policy engagement to address threats to democracy.

HONGJIE DONG
Professor of Applied Mathematics
- Fellow, Simons Foundation
- Fellow, Institute for Advanced Study

SASHA-MAE ECCLESTON
John Rowe Workman Assistant Professor of Classics
- Postdoctoral Fellowship, Ford Foundation, 2020–2021

MICHAEL FRANK
Edgar L. Marston Professor of Psychology
- Troland Research Award, National Academy of Sciences

KAREN FURIE
Samuel I. Kennison MD and Bertha S. Kennison Professor of Clinical Neuroscience, Professor of Neurology
- C. Miller Fisher MD Neuroscience Visionary Award, American Stroke Association

SUSAN A. GERBI
George D. Eggleston Professor of Biochemistry
- Brown Distinguished Research Achievement Award

WILLIAM GOEDEL
Assistant Professor of Epidemiology (Research)
- Elected member, Strategy Group on COVID-19 and Rental Evictions, National Academies of Sciences, Engineering and Medicine

PRADEEP GUDURU
Professor of Engineering
- James R. Rice Medal, Society of Engineering Science, 2020

TRACEY GUTHRIE
Associate Professor of Psychiatry and Human Behavior, Associate Professor of Medical Science, Clinician Educator
- Chair-Elect, American Association of Directors of Psychiatric Residency Training

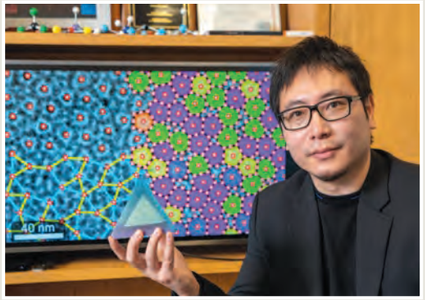
YANNIS HAMILAKIS
Joukowsky Family Professor of Archaeology, Professor of Modern Greek Studies
- Fellow, Bard Graduate Center

FRANÇOISE HAMLIN
Royce Family Associate Professor of Teaching Excellence in Africana Studies and History
- Edmond J. Safra Center for Ethics Fellowship, Harvard University
- George A. and Eliza Gardner Howard Foundation Fellowship

JULIET HOOKER
Professor of Political Science
- Brown Presidential Faculty Award, Fall 2020

NAZ KARIM
Assistant Professor of Emergency Medicine
- Emergency Medicine Globalization and Advancement Award, Global Emergency Medicine Academy, Society for Academic Emergency Medicine

COURTESY SUSAN GERBI; KINDRA CLINEFF



OU CHEN
Chemistry
Early Career Research Achievement Award
Ou Chen researches the development of novel materials, including nanocrystals. His research team is finding new uses for quantum dots and has discovered a new quasicrystalline lattice, a type of nanomaterial. He has published more than 50 peer-reviewed papers since joining Brown in 2015 and has initiated an annual STEM Day for local high school students. In 2020 he earned a Sloan Research Fellowship award, a CAREER award from the National Science Foundation, and a 3M faculty award, and he was named a Dreyfus Teacher-Scholar.

SUSAN GERBI
Molecular biology, cell biology and biochemistry
Distinguished Research Achievement Award
Susan Gerbi has been influential in advancing knowledge about the structure, evolution, and biogenesis of ribosomes and instrumental in developing new methods for mapping DNA replication origins. She has received many appointments and honors during her career, was founding chair of her department, and is an advocate for the translation of biology into medical applications for cancer and antibiotics.

BROWN RESEARCH INDEX

ANGUS KINGON
Barrett Hazeltine University Professor of Entrepreneurship and Organizational Studies, Professor of Engineering
- Senior Scholar Award, Fulbright Association

MATTHEW KRAFT
Associate Professor of Education
- Scholar, William T. Grant Foundation

ANDREW LAIRD
John Rowe Workman Distinguished Professor of Classics and Humanities, Professor of Hispanic Studies
- Loeb Fellowship, Harvard University

KATHERINE E. MASON
Associate Professor of Pediatrics
- 2021 Robert S. Holm Leadership Award, Association of Pediatric Program Directors

ALYSON MCGREGOR
Adjunct Professor of Emergency Medicine
- Lila A. Wallis Award, American Medical Women's Association

JENNIFER E. MERRILL
Associate Professor of Behavioral and Social Sciences
- Brown Early Career Research Achievement Award

VINCENT MOR
Professor of Health Services, Policy, and Practice, Florence Pirce Grant University Professor
- Susan Colver Rosenberger Medal of Honor

ALAN MORRISON
Assistant Professor of Medicine
- Harold S. Geneen Charitable Trust Award

JEFFREY MOSER
Assistant Professor of History of Art and Architecture
- Senior Fellow, Center for the Advanced Study of the Visual Arts, National Gallery of Art, Washington, D.C.

EMILY OWENS
David and Michelle Ebersman Assistant Professor of History
- Career Enhancement Fellow, Institute for Citizens and Scholars

NITIN P. PADTURE
Otis Everett Randall University Professor of Engineering
- Brown Presidential Faculty Award, Spring 2021

BENOÎT PAUSADER
Professor of Mathematics
- Fellow, Simons Foundation

JENNIFER MERRILL
Behavioral and social sciences
Early Career Research Achievement Award
Jennifer Merrill's research focuses on the causes and consequences of alcohol misuse among young adults. She has received multiple federal grants for her research, which is designed to inform interventions for health and safety issues associated with alcohol. She has authored more than 80 peer-reviewed publications with other Brown faculty and outside collaborators and holds early career awards from the Research Society on Alcoholism and the American Psychological Association.

KAVITA RAMANAN
Applied mathematics
Distinguished Research Achievement Award
Kavita Ramanan's research focuses on probability theory and stochastic processes and involves creating new mathematical frameworks for the study of random phenomena. She has authored over 70 publications and holds four U.S. patents. She has won the Erlang Prize for outstanding contributions to applied probability, a Simons Fellowship, a Guggenheim Fellowship, and a 2020 Newton Award from the U.S. Department of Defense for Transformative Ideas during the COVID-19 Pandemic.

KINDRA CLINEFF; DEIRDRE CONFAR

FRANK SELLKE
Cardiothoracic surgery
Distinguished Research Achievement Award
Frank Sellke specializes in the study of microvascular cardiac injury. His translational research focuses on optimizing cardiac surgery outcomes. His research has been funded by the National Institutes of Health for more than 28 years. He is professor of cardiothoracic surgery at the Warren Alpert Medical School and chief of cardiothoracic surgery at Rhode Island Hospital and the Miriam Hospital. He has won many awards for his work, served on the editorial boards of nine journals, and edited three textbooks, and he has more than 540 peer-reviewed publications.

PATRICIA POITEVIEN
Assistant Professor of Pediatrics, Clinician Educator
- President-Elect, Association of Pediatric Program Directors

STEPHEN PORDER
Professor of Ecology, Evolution, and Organismal Biology and Environment and Society
- Fulbright-Tocqueville Distinguished Chair, Institut de Physique du Globe de Paris

KAVITA RAMANAN
Roland George Dwight Richardson University Professor of Applied Mathematics
- Brown Distinguished Research Achievement Award
- U.S. Department of Defense Vannevar Bush Faculty Fellow

MARK J. RIVARD
Professor of Radiation Oncology
- Ulrich Henschke Lifetime Achievement Award, American Brachytherapy Society

MICHAEL SATLOW
Professor of Judaic Studies and Religious Studies
- Public Scholar Fellowship, National Endowment for the Humanities

REBECCA SCHNEIDER
Professor of Modern Culture and Media
- Fellow, John Simon Guggenheim Memorial Foundation

FRANK W. SELLKE
Karl E. Karlson MD and Gloria A. Karlson Professor of Cardiothoracic Surgery, Professor of Surgery
- Brown Distinguished Research Achievement Award

SAMIR SHAH
Clinical Professor of Medicine
- President, American College of Gastroenterology

SUSAN SHORT
Professor of Sociology
- Fellow, American Association for the Advancement of Science

PATRICIA SOBRAL
Distinguished Senior Lecturer in Portuguese and Brazilian Studies
- Inaugural recipient, Prêmio Clémence Jouët Pastré de Incentivo à Língua Portuguesa

DOMINICK TAMMARO
Professor of Medicine
- Dema C. Daley Founder's Award, Association of Program Directors in Internal Medicine

NICOLE GONZALEZ VAN CLEVE
Associate Professor of Sociology
- Radcliffe Fellow, Harvard Radcliffe Institute

BETTY VOHR
Professor of Pediatrics
- Virginia Apgar Award, Section on Neonatal-Perinatal Medicine, American Academy of Pediatrics

COMPILED BY CHANELLE DUPUIS, GRADUATE STUDENT FRENCH STUDIES PHD

KINDRA CLINEFF

1. Conceptual rendering of the future Performing Arts Center (PAC) as seen from the Granoff Center
2. Construction progress on the PAC as seen from Page-Robinson Hall in January 2022.
3. Avery Willis Hoffman, Brown's first artistic director, stands in the Granoff Center for the Creative Arts with the Performing Arts Center under construction in the background. Willis will be program curator for both spaces, charged with positioning Brown as a leader in the arts world.

LUXIGON; KINDRA CLINEFF

Uplifting the Arts

A conversation with Avery Willis Hoffman, artistic director of the Brown Arts Institute

BY SHERRI MILES

THE FUTURE OF ARTS EXPLORATION at Brown rises from the nexus of its highly anticipated performing arts center, a new arts institute, and its first-ever artistic director, Avery Willis Hoffman, whose charge is to position Brown as a leader in providing diverse opportunities for rigorous artmaking, scholarship, and creative experimentation.

The Performing Arts Center (PAC), with its one-of-a-kind flexible design, is on pace to publicly open in Fall 2023 and will serve as the heart of theatre, dance, and music on campus. The Brown Arts Institute (BAI), established in July 2021 on a foundation of decades of faculty collaboration in the arts, supports and works in concert with six academic arts departments and affiliated programs, including visual art, music, history of art and architecture, literary arts, modern culture and media, theatre arts and performance studies, Africana studies/Rites and Reason Theatre, and the David Winton Bell Gallery.

Hoffman's curatorial practice and scholarship will shape the artistic director role; she earned undergraduate and doctoral degrees in classics and English literature and brings to campus deep professional experience in multidisciplinary arts. She leads the BAI alongside Faculty Director Thalia Field in setting and executing BAI's mission and goals, integrating artistic and academic programs, and curating visiting artist projects to be presented at the PAC and beyond.

In a conversation with *Impact*, Hoffman shares her vision about what's next in the evolution of arts at Brown.

Q. What was it like starting your new role at Brown during COVID-19 when the campus was closed?

AVERY WILLIS HOFFMAN: Despite all that has been terrible about COVID-19, there's been a silver lining. I've been given space to think and meet a lot of people from across the country and the world—students and faculty and alumni and parents—and I'm not sure I would have been able to meet so many people had I been on campus in the thick of programming. I've been having really in-depth conversations with artists and folks thinking about the trajectory of the arts through the pandemic and where we need to go in the future.

Q. Brown has never had an artistic director before. What opportunities does this new position present?

AWH: I've worked in the arts for so long and in so many capacities that in many ways this is the dream job that brings together all the things I've done in my career. An artistic director in the industry is a scout, seeking out the best and most interesting new work. Where are artists pushing boundaries or responding to critical social issues? An artistic director is also a programmer, thinking through meaningful combinations of programs and artists in a space. I'm very interested in reimagining what an artistic director does. It should be a collaborative, not solitary, position that really looks across the campus and starts to make connections and find ways for those creative enterprises to thrive and be uplifted. I'm at the beginning of modeling what this position can be. I don't think it has to be a replication of what it is in the world, and that's pretty exciting.

Q. What priorities do you have for the Brown Arts Institute?

AWH: I've been thinking a lot about three main priorities. The first is to invite a cohort of artists to join us in a longer-term relationship that fosters collaboration with our campus and offers multiple meaningful moments of interactivity (as opposed to focusing on a single presentation). We're calling this the Artistic Innovators program—a community of 30 or 40 artists whom we're identifying as boundary-pushing, interdisciplinary, and courageous.

My second priority is looking for ways to collaborate with different campus units and support the projects that are already in motion amongst the students, faculty, and departments, and more broadly to explore how we can partner with local artists and organizations to share their work on College Hill.

And the third priority is workforce development. We are going to be bringing incredible productions to campus, and we need to staff those productions. We need to have box office and front of house staff, stage managers, technical and production staff, sound and lighting designers, and so on. We're thinking about creating an ArtsCorps, akin to a Peace Corps or AmeriCorps, where we can holistically support a community of arts workers who have suffered greatly during the pandemic.

Q. How do you view research in the arts?

AWH: One of the most intriguing things for me about being on a college campus is the fruitful intertwining of scholarship, research, and practice. Artists approach research in a different way than scholars do, and I have found that the intersection of art and scholarship can be very fruitful.

Some artists do deep, deep research around the topics that they're passionate about and that they want to produce work around. And they also really benefit from conversations with scholars and professors in their fields of interest or testing out material with young, brilliant minds. What we're looking at is a model that starts to integrate artists into the scholarly community and scholars into the artistic community.

Q. Why is evolving the arts at Brown so important at this time?

AWH: I commend the president and the provost for shining a light on the arts right now, especially as the pandemic has revealed some deep inequities that must be addressed for the future health of our society. They recognize that the integration of artistic programming and academic programming really supports the growth of students into good citizens who are capable of creative problem-solving. They've identified that this campus is creatively driven and chose to put resources towards a space that will showcase that creativity and encourage collaboration.

The commitment shows that Brown can be a leader in this kind of integrated academic and artistic enterprise. It's really forward thinking, and it's an incredible charge to think about how we continue to solidify Brown's position in the arts and the arts world. ■