

BROWN TECHNOLOGY INNOVATIONS

2023 Annual Report



The Year in Review

Dear Colleagues,

As your center for innovation, Brown Technology Innovations continues to grow in tandem with the University's initiatives to support research and to align it both internally and with our health care partners. Our efforts reflect this activity, with increases in our intellectual property deal flow and a timely rebound in industry-sponsored research.

What marked our fiscal year 2023 campaign was the balance of Brown's technology and research portfolio between life science technologies and high-tech ones. Highlights include the initial public offering of a Brown startup from the Division of Biology and Medicine, a slew of industry research agreements for engineering faculty, and the honoring of a Brown physics professor as one of the University's most successful inventors.

Looking ahead to fiscal year 2024, Brown Technology Innovations will increase its involvement in the University's ecosystem development and update its strategy to reflect the continued growth and maturation of innovation at Brown.

Sincerely,

A handwritten signature in blue ink that reads "Neil Veloso". The signature is fluid and cursive.

Neil Veloso
Executive Director

Brown Technology Innovations Industry and Investor Advisory Board

Our advisory board members are experienced executives, investors and entrepreneurs who inform our strategy and connect us to entrepreneurs who can help develop commercial pathways for Brown faculty inventions. They represent a variety of disciplines and perspectives that help shape the trajectory of our growth.

Kristopher Brown, Partner,
Goodwin Law

Neil Cohen, Chairman, Emerald
Development Managers

Rich Ganz, Executive Chairman,
Sentien Biotechnologies Inc.

Walter Jin, Chairman and Chief
Executive Officer, Pager Inc.

Keith Kerman, M.D., Operating
Partner and Senior Advisor, The
Riverside Company

Rajiv Kumar, M.D., Co-Founder, Brown
Angel Group

Kirsten Leute, Partner, University
Relations, Osage University Partners

Annie Mitzak, Partner, Cure Ventures

Sara Nunez-Garcia, Co-Founder,
Partner, Forty51 Ventures

Jeff Pootalal, Managing Director,
Sixth Street Partners

Greg Sieczkiewicz, J.D., Ph.D.,
Executive Partner and Chief IP
Counsel, MPM Capital

A Year in Numbers:

2022–23

Brown Technology Innovations

Brown Technology Innovations' Activity Metrics, FY22 vs. FY23

Strategic Priority	Put Brown Technology First	Steward Brown Inventions	Amplify Marketing + Networking Tactics	Streamline Deal Execution				
	Measure	Disclosures	Patents Issued	CDAs	Options	Exclusive Licenses	Non-Exclusive Licenses	SRAs
	Q1	17	6	18	1	1	2	5
	Q2	26	12	16	4	3	0	5
	Q3	32	7	13	1	0	0	2
	Q4	19	5	13	1	2	1	6
	FY22	87	19	66	6	5	19	15
	FY23	94	30	60	7	6	3	18

CDAs: Confidentiality Agreement; SRAs: Sponsored Research Agreement

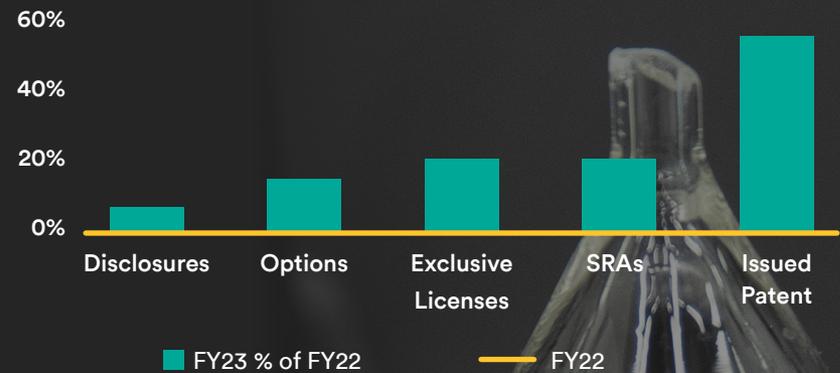
Brown Biomedical Innovations to Impact Fund

Brown Biomedical Innovation to Impact (BBII) is a biomedical technology development program that accelerates the timeline for turning faculty discoveries into potential products with clinical impact. We have made 21 awards to 19 faculty inventors/technologies totaling \$2.1M in funding. Additionally, four startup companies have been formed that have raised about \$3M in seed investment or non-dilutive funding.

- > The fifth annual BBII proposal cycle yielded awards for three projects:
- > an app that tracks and helps treat chronic pain — the first digital therapeutic BBII has funded;
- > a device that aims to correct skin color bias in blood oxygen level testing; and
- > a method to isolate single tumor cells for better diagnosis and, potentially, treatment.

[Read more about these awards.](#)

Selected growth in deals



Strategy Report

Fiscal year 2023 featured a focus on our Entrepreneur Connect program to identify entrepreneurs to pair with faculty innovation and create fundable startups. The last three Brown startups (PedialyDx, Walah Scientific and XM Therapeutics) are all led by serial entrepreneurs. We plan to mine our current roster of entrepreneurs, executives, postdocs and graduate students to helm the next wave of University ventures.

With the implementation of Brown's Operational Plan for Investing in Research, Brown Technology Innovations is looking to retool its approach toward industry agreements. We are looking to capitalize on our gains from this year to examine our industry SRA business from all angles, including sourcing, faculty and research areas and relationship management.

Finally, keep an eye out for increased Brown Technology Innovations programming in FY24. These efforts were launched in FY23 but will come to fruition this fiscal year with an inaugural showcase, as well as faculty and student outreach around innovation.

➤ Goal 1: Put Brown Technology First

Prioritize areas of strength and high potential, focus on technology and inventions, and connect to industry interests and market needs



The Division of Biology and Medicine was the biggest contributor to the 94 total invention disclosures, with more than double the new inventors of the next closest department (Engineering). Life science inventions (coming from all schools and departments) made up slightly more than half (53%) of the total yield. We are seeing the emergence of the “serial inventor” as well, with 16 inventors being responsible for 47% of our invention disclosures.

In keeping with our theme of Put Brown Technology First, we spent a good deal of FY23 planning our inaugural [Innovation@Brown Showcase](#). This exciting event puts the spotlight on Brown startups, research and emerging technology for an audience of investors, entrepreneurs, researchers and executives. Holding the event at the 225 Dyer Street space also reinforces the Jewelry District as a center of gravity for research, innovation and new ventures at Brown.

➤ Goal 2:

Steward Brown Inventions

Provide excellent service to the faculty customer and manage intellectual property budget to maximize benefit to investors and inventors



Faye Maris (pictured) accepts the Career Innovation and Impact Award on behalf of her spouse, Humphrey (not pictured), from Jill Pipher, vice president for research, and Brown Technology Innovations executive director Neil Veloso during the 2023 Celebration of Research.

Among the most successful Brown faculty inventors is Professor Emeritus of Physics Humphrey Maris, who is responsible for inventions in non-destructive evaluation for semiconductor manufacturing. Maris has 25 invention disclosures and 57 issued patents. The Brown community had an opportunity to celebrate Maris for his work at the 2023 Celebration of Research event put on by the Office of the Vice President for Research. (In keeping with the example set by Maris, Brown faculty members received 30 new U.S.-issued patents in FY23, a 58% increase.) Representing Maris was his wife Faye, whose remarks highlighted her husband's commitment to his students, his research and Brown.

➤ Goal 3:

Marketing and Networking

Connect with high-potential customers through multiple channels and engage advisor network to inform strategy and refer entrepreneurs

Our FY23 marketing and networking activities traversed both external and internal activities that focused on engaging with our customer bases of investors, entrepreneurs, companies and faculty inventors. Having the 2023 Biotechnology Innovation Organization (BIO) International Convention in Boston allowed us to send a four-person group (coordinated by Senior Director of Business Development Andrew Bond) to cover the conference with an eye toward developing company relationships for industry-sponsored research. Additionally, business development directors Brian Demers and Victoria Campbell attended (for the first time) the TechConnect conference with its registrant base of engineering companies.



Brown Technology Innovations' business development directors (left to right: Brian Demers, Victoria Campbell, Andrew Bond and Melissa Simon) were active on the conference circuit in FY23.

We were very active on campus as well, with innovation-oriented programming and events for Brown faculty, graduate students and postdocs. Business development director Melissa Simon hosted entrepreneurship luncheons for faculty and grad students/postdocs to build communities within those groups. Brown Technology Innovations continued to engage with the investor community. We hosted General Inception (an investor in Walah) to meet with Brown faculty and organized meetings with the Rhode Island-based Cherrystone Angel Group, to host member meetings at South Street Landing featuring faculty members (Kimani Toussaint and David Borton to date) speaking about their research to an audience of sophisticated investors.

➤ Goal 4: Deal Execution

Focus on patent licensing and industry-sponsored collaborations, to streamline processes and mechanisms to ensure the highest-quality deals



Assistant Professor of Computer Science Chen Sun

It is gratifying to see Brown research enter the marketplace, with the resultant impact on society. The fibrosis and malaria research of professors Jack Elias and Jake Kurtis, respectively, was recognized when Ocean Biomedical, a sublicensee of Brown startup Elkurt, made its public debut on the Nasdaq Stock Market in FY23.

Switching our focus from the public markets to Brown's deal activities, there is no lack of good news. Two new startups, XM Therapeutics and Walah Scientific, were launched from the work of professors Jeffrey Morgan and Will Fairbrother in the therapeutic and diagnostic spaces, respectively. Led by seasoned industry veterans and supported by upper-tier venture investors, these startups represent the diversity of research and discovery at Brown. A focus on intellectual property options and exclusive licenses to startups and emerging companies allowed Brown Technology Innovations to increase its deal flow by 17% and 20% in these two key categories.

Assistant Professor of Computer Science Chen Sun was no less active on the industry research side. His work around computer vision, machine learning and artificial intelligence has yielded research collaborations leading technology and manufacturing companies. Indeed, Brown's new industry-sponsored research agreement deals grew by 20% in FY23, reflecting further industry interest and backing for faculty research.



(Top to bottom) Ocean Biomedical enjoyed its Nasdaq debut in 2023

XM Therapeutics CEO Frank Ahmann

News in Focus: Our Top Stories from FY23

BROWN *Invents* »»

Designing a More Inclusive Pulse Oximeter

Pulse oximeters fail to accurately measure blood oxygen levels in patients of color. To combat this issue, Brown doctoral student Rutendo Jakachira of the Toussaint Lab is developing a pulse oximeter that works on all patients, regardless of melanin levels.

» Read: [Press release](#)

TissueSHOCK Technology a Global Innovation Award Finalist

Biomedical engineering Ph.D. candidate Cel Welch and Professor of Engineering Anubhav Tripathi were among the top five global finalists for Most Innovative Solution in Digital Health and Social Care, part of the 2022 Engineering and Technology Innovation Awards, co-sponsored by E&T magazine and the Institution of Engineering and Technology. Their TissueSHOCK technology presents a novel electrical method to dissociate tissues for downstream single-cell analysis.

» Read: [Press release](#)

Bolden Therapeutics Awarded Two SBIR Grants

Brown startup Bolden was awarded two Small Business Innovative Research (SBIR) grants for \$497,500 and \$406,466 from the National Institute on Aging of the National Institutes of Health. Bolden Therapeutics is a biotechnology company that develops therapeutics to promote neurogenesis in patients with diseases that affect cognition, such as Alzheimer's.

» Read: [Press release](#) and [Press release](#)

Ocean Biomedical to Combine with Aesther Healthcare

Aesther Healthcare Acquisition Corp., a special-purpose acquisition company, and Ocean Biomedical Inc., a next-generation biopharma company, announced in January that Aesther had filed with the U.S. Securities and Exchange Commission a definitive proxy statement in connection with its proposed business combination with Ocean.

» Read: [Press release](#)

Humphrey Maris Receives Inaugural Career Innovation and Impact Award

Humphrey J. Maris, professor emeritus of physics and professor of physics, received Brown Technology Innovation's Career Innovation and Impact Award on April 24 for his groundbreaking work in ultrafast ultrasonics and semiconductor metrology and technology.

» Read: [Press release](#)

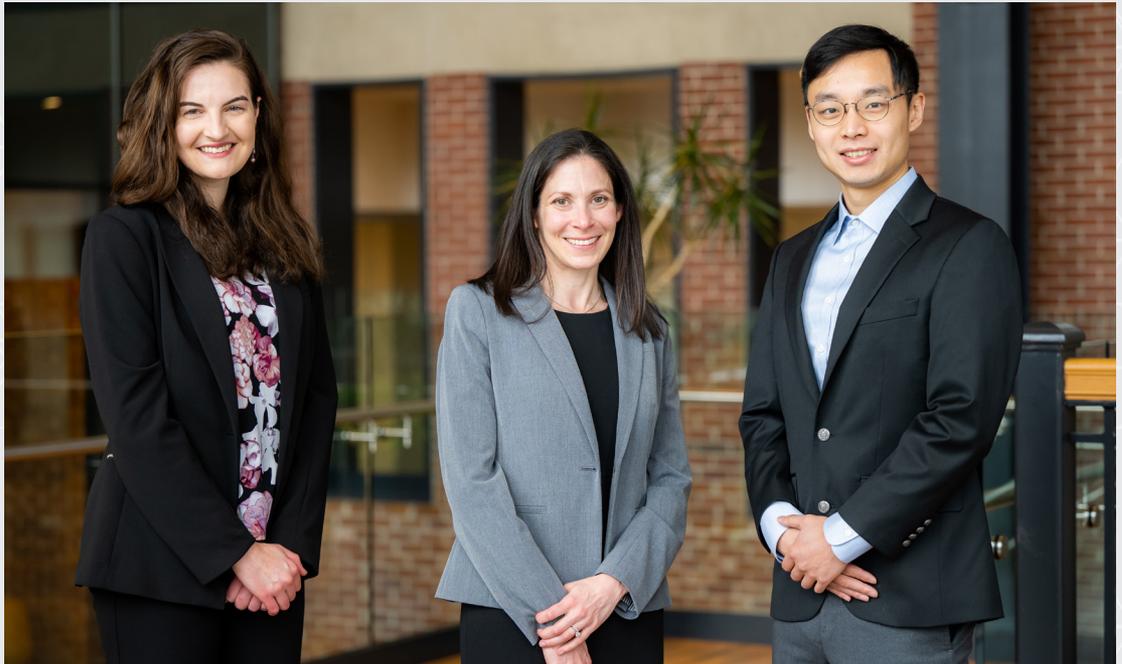
Brown Ranked 19th in PitchBook's 2022 Startup Rankings

PitchBook released its rankings for the top 100 colleges producing the most entrepreneurs who have founded venture capital-backed companies. Brown came in 19th with a total of 511 founders, 476 companies and a sum total of \$34.9 billion raised.

» Read: [Press release](#)

Brown Innovation Fellows Program Provides Training in Technology Commercialization

By Kathleen Meininger,
Brown Class of 2023



2022 Innovation Fellows Josephine Kalshoven (left) and Xiaozhou Fan (right) with BTI business development director Melissa Simon (center)

Xiaozhou Fan, a fourth-year engineering Ph.D. student, spends most of his time in the lab, designing drones that mimic the biomechanics of birds and bats during flight and studying their aerodynamics. While Fan has spent the last four years delving deep into the field of fluid dynamics, his interests expand beyond his research and into the wider application of devices such as the ones he is trying to design.

That is why Fan makes the trip from his lab to the Brown Technology Innovations (BTI) office once a week, where he has interned as a Brown Innovation Fellow since Fall 2022. He meets with his supervisor, Brian Demers, to review invention disclosures and patent applications submitted by principal investigators in the engineering and physics departments. His task is to evaluate whether the products these researchers are trying to patent have potential commercial value.

“We ask, what's the competitive advantage of this technology compared to the existing state of art. Is there a market? And if there is a market, how big is it?” Fan said. “We also look at key challenges in converting this piece of technology into commercialized products. And finally, whether there are companies that would be interested in licensing this technology.”

Melissa Simon, a BTI director of business development, started the Brown Innovation Fellows program in 2022 to provide graduate students and postdocs with experience in technology evaluation and commercialization.

Simon completed a similar program at Columbia University's technology transfer office as a Ph.D. student. "It was an amazing opportunity to get exposure outside the lab and learn how to commercialize technology," Simon said. "So when I came here two years ago, it was really something I wanted to bring to our office."

The 2022 program consists of four fellows: two Ph.D. students, including Fan, an M.D. student, and M.D.-Ph.D. student Alex Wong. Wong's research uses machine learning to predict novel combinations of cancer drugs. The Brown Innovation Fellows program has provided her with a lens through which to think about her research in terms of real-world consequences. When choosing her specific research topic, she emphasized her focus on concrete approaches for patients and found a clear path for her project to accelerate cancer therapeutics development and drug repurposing efforts.

"The Innovation Fellows program really did shape how I wanted to do my Ph.D.," Wong said.

Wong's experience in the program has also taught her to think critically about marketing intellectual property, including how to communicate research effectively. She believes these skills will benefit her in her future career as a physician-scientist.

"Ideally as an M.D.-Ph.D., I will be at this intersection of identifying problems that patients face on a daily basis, researching different solutions to those problems, and then bringing those discoveries back to my patients," Wong said.

This is a career that allows her to sit at both ends of the research pipeline, to make discoveries and apply them to patient care. Having the skills to bridge this gap between research and

research application is especially important.

"Technology transfer and commercialization is a totally different section of the pipeline that isn't covered within an M.D.-Ph.D. The Brown Innovation Fellows program fills in that gap," she said.

Fan also highlighted the opportunity the Brown Innovation Fellows program provides him to gain a more comprehensive view of his field. "As a researcher I only get a very small portion of the rest of the story. I feel like a lot of this research that we do here at Brown, we want to have a bigger impact," he said. "Academic journals are definitely important. But we also want to reach a wider audience rather than just experts. I think this is a golden opportunity to do that."

Fan plans to continue on a career path in academia, and he feels his experience in the Brown Innovation Fellows program is already opening doors. "In one of my postdoc interviews, a professor looked at my CV and saw that I am an Innovation Fellow and interested in startups. And he started a conversation with me purely on that."

Feedback on the program from across the University has been positive, Simon said, "Not just from the students, but also faculty members that say 'I want my students to participate in this.'"

The program is recruiting another group of students to start as BTI Fellows in Fall 2023.

"We want to increase the breadth of projects that the students are exposed to," Simon said, "and as students gain experience, to be able to expose them to more and more opportunities that are not only helpful for our office, but also benefit their individual career trajectories." •

Faculty Focus

Clinical and Applied Research: New Treatments and Therapies

Originally published in the June 2023 issue of IMPACT

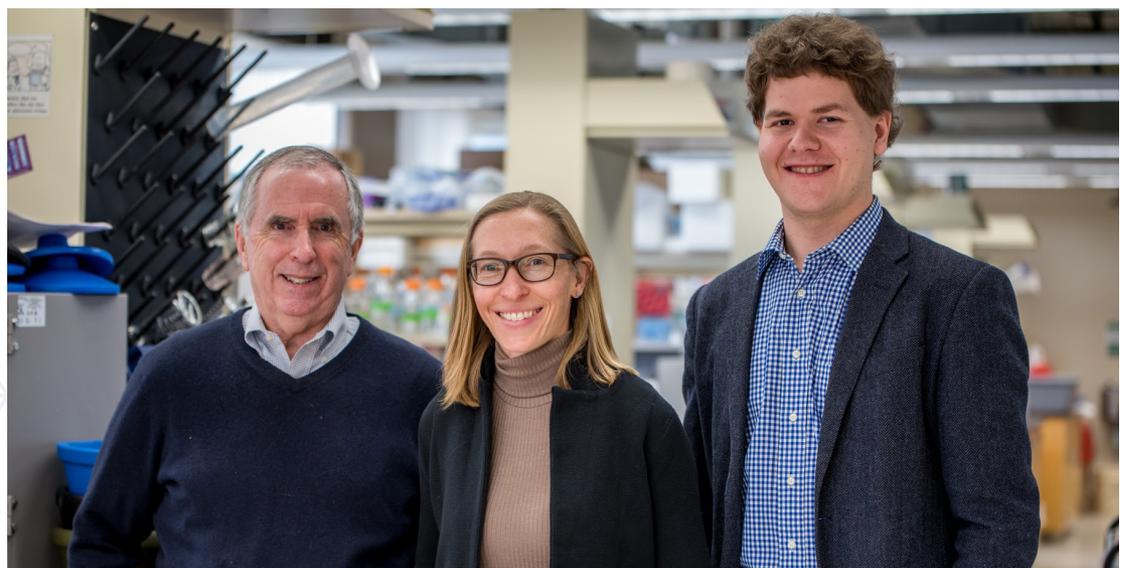
Many researchers at Brown are already building on the work of their peers and are actively creating treatments for diseases of aging. These scientists are partnering with older patients to conduct observational studies or are entering clinical trials for new drugs. Their innovative work could lead directly to therapies and diagnostic tools that will help us thrive well into our sunset years.



Early Action

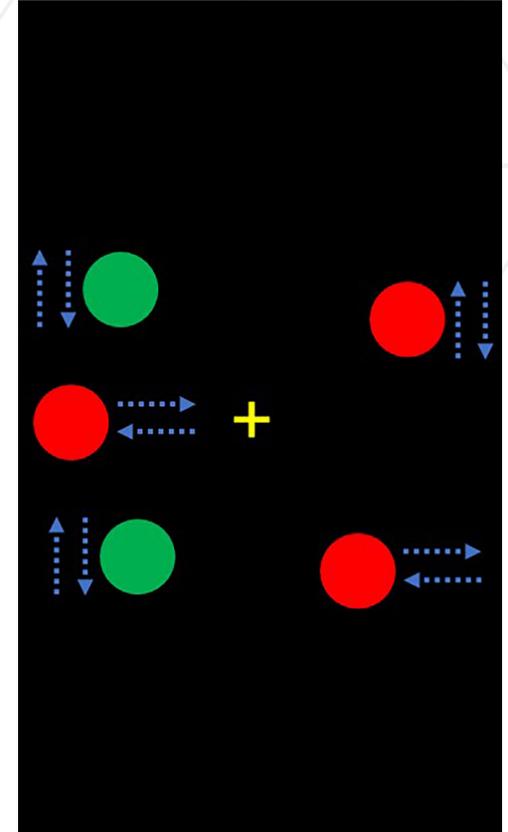
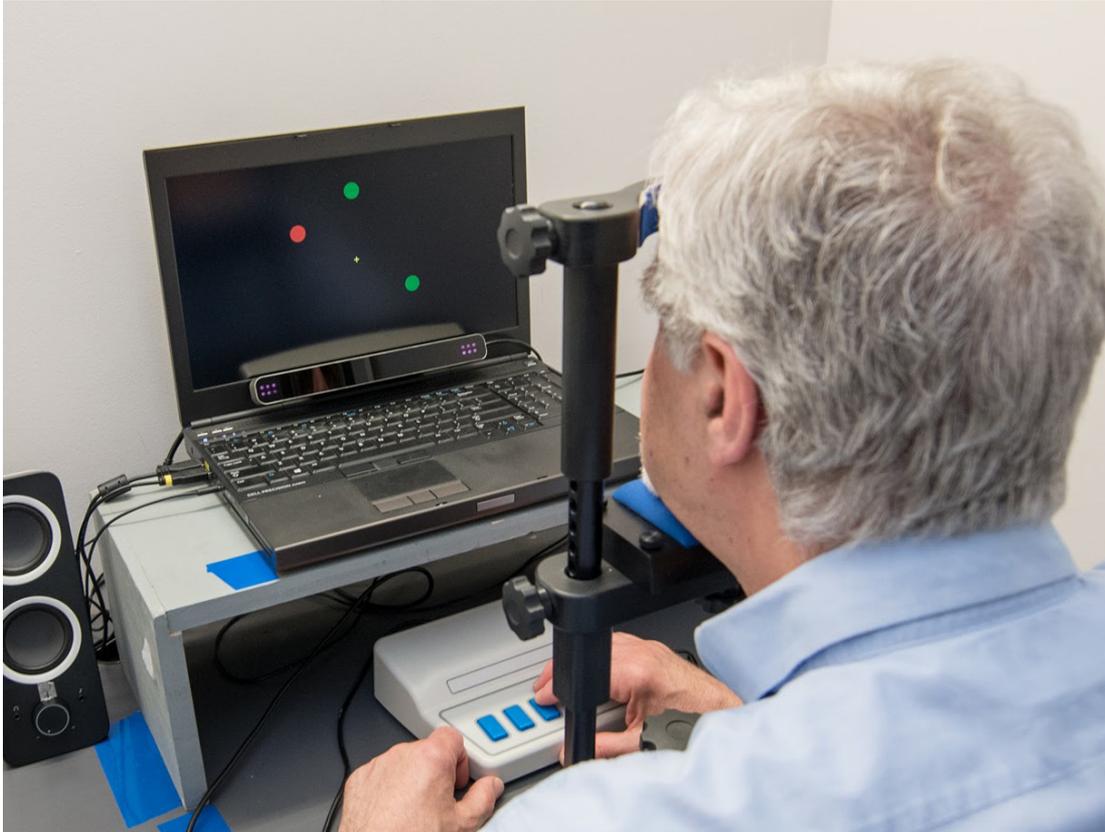
William Heindel, professor of cognitive, linguistic, and psychological sciences, is one of those researchers. With his colleague, Senior Lecturer Elena Festa, he's working on ways to spot neurological diseases like Alzheimer's and other forms of dementia early in their course before patients show any symptoms. To do so, he's using a series of deceptively simple computerized tests that can reveal if cognitive damage is happening in the brain even a decade or two before symptoms appear.

The tests challenge two components of our visual system that process what we see through two distinct neural pathways or "streams." The first, called the dorsal stream, processes motion, luminance, contrast, and black-and-white elements of our vision; the second, called the ventral stream, handles object recognition and processes color. Both streams must work together seamlessly to coherently assess what we see.



Top: Yufei Lin, graduate student, conducts aging research in John Sedivy's lab at the Center on the Biology of Aging.

Bottom: Justin Fallon, Ashley Webb and Johnny Page are co-founders of the biotechnology company Bolden Therapeutics, which received Brown's 2022 Startup of the Year award.



Left: William Heindel demonstrates a cognitive test he developed with colleague Elena Festa, senior lecturer in cognitive, linguistic and psychological studies, that can reveal whether cognitive damage is happening in the brain long before symptoms of neurological disease appear.

Right: With their new imaging technique, the Lee lab generated an image of a brain microvasculature network in which different levels of betweenness, a key network property, were represented by a range of colors.

Heindel's tests probe this connection. In the lab, a video screen shows many green dots moving left to right and red dots moving up and down, while a single green dot moves only up and down. Participants are asked to track this green dot with their eyes, and since doing so requires processing both motion (the dorsal stream) and color (the ventral stream), slight delays in their reaction, even just a by few milliseconds, can show that the link between both streams is breaking down.

"That's the beauty of certain cognitive tests like this. You don't necessarily need medical imaging to see what's going on in the brain," Heindel said.

Replacing Neurons

Spotting age-related disease is only half the battle; treating it is just as important. Justin Fallon, professor of neuroscience, and Ashley Webb, assistant professor of molecular biology, cell biology, and biochemistry, are working toward that goal along with Johnny Page, a former student of Fallon. Together they've created Bolden Therapeutics, a new biotech company based on their collaborative research.

Bolden aims to find treatments for various neurodegenerative diseases, from Alzheimer's to ALS. These diseases kill off neurons in the brain through multiple means, leaving gaps in its complex circuitry. The team wants to replace missing neurons entirely to fix those broken connections, which could restore patients' original brain function.

This may be possible by targeting stem cells in the hippocampus, a region of the brain that plays a central role in learning and memory, Webb said. Early in life, those cells crank out neurons regularly, but the older we get, the fewer they produce. A new therapy they are developing may offer a way to boost the activity of those cells on demand, creating new neurons whenever needed.

"That might be useful for normal cognitive decline as well as in situations like Alzheimer's disease, which destroys cells in the hippocampus early on," Webb said. "If we can figure out ways to replace the neurons that are lost in Alzheimer's, that would be a game changer."

Currently the researchers are testing their RNA therapy in mice and on human cells in the lab. If successful, the drug will move into clinical trials in the next few years, bringing the world closer to a treatment for millions of patients worldwide.

An Ounce of Prevention

Professor of Biology John Sedivy is also working on ways to treat age-related diseases in the brain. Instead of rebuilding damaged neurons, he's focusing on a method to stop or slow that damage.

Sedivy, director of Brown's Center on the Biology of Aging, studies cells that have entered senescence, a semidormant

state that causes inflammation in surrounding tissue. If too many cells in the brain become senescent, he said, the resulting inflammation can damage or destroy neurons, causing diseases like ALS and dementia.

One cause of cell senescence in the brain may be retrotransposons, virus-like stretches of genetic code in our DNA. If activated, these bits of code can replicate themselves and damage cells. Sedivy's lab discovered that cells also mistake retrotransposons for real viruses and mount antiviral defenses that fuel chronic inflammation. Through his biotech startup, Transposon Therapeutics, Sedivy is working towards a treatment that can stop that scenario from unfolding. He's currently in early clinical trials for a new drug that can block retrotransposons in human brain cells and ultimately may prevent neurons from dying off in patients with ALS or Alzheimer's.

"We're discovering new things all the time," he said.

"Retrotransposons have been known for decades, but they haven't attracted a lot of attention in the medical world. We're really firmly connecting them with disease."

Each of these researchers has a tangible sense that the process of aging is, essentially, the process of living. It's an inextricable part of who we are; from the day we're born, it's a steady presence wherever we go. Just because our bodies are perpetually aging doesn't mean we're destined to end our days in illness, though: thanks to the clinical research Brown scientists are doing today, we may be able to stay healthy and mentally sharp late in life. ●



(Left to right) Josephine Kalshoven, Xiaozhou Fan, Jennifer Vieira, Leonard Katzman, Victoria Campbell, Neil Veloso, Melissa Simon, Brian Demers, Karen Bullock, Andrew Bond and Rebecca Rossi



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