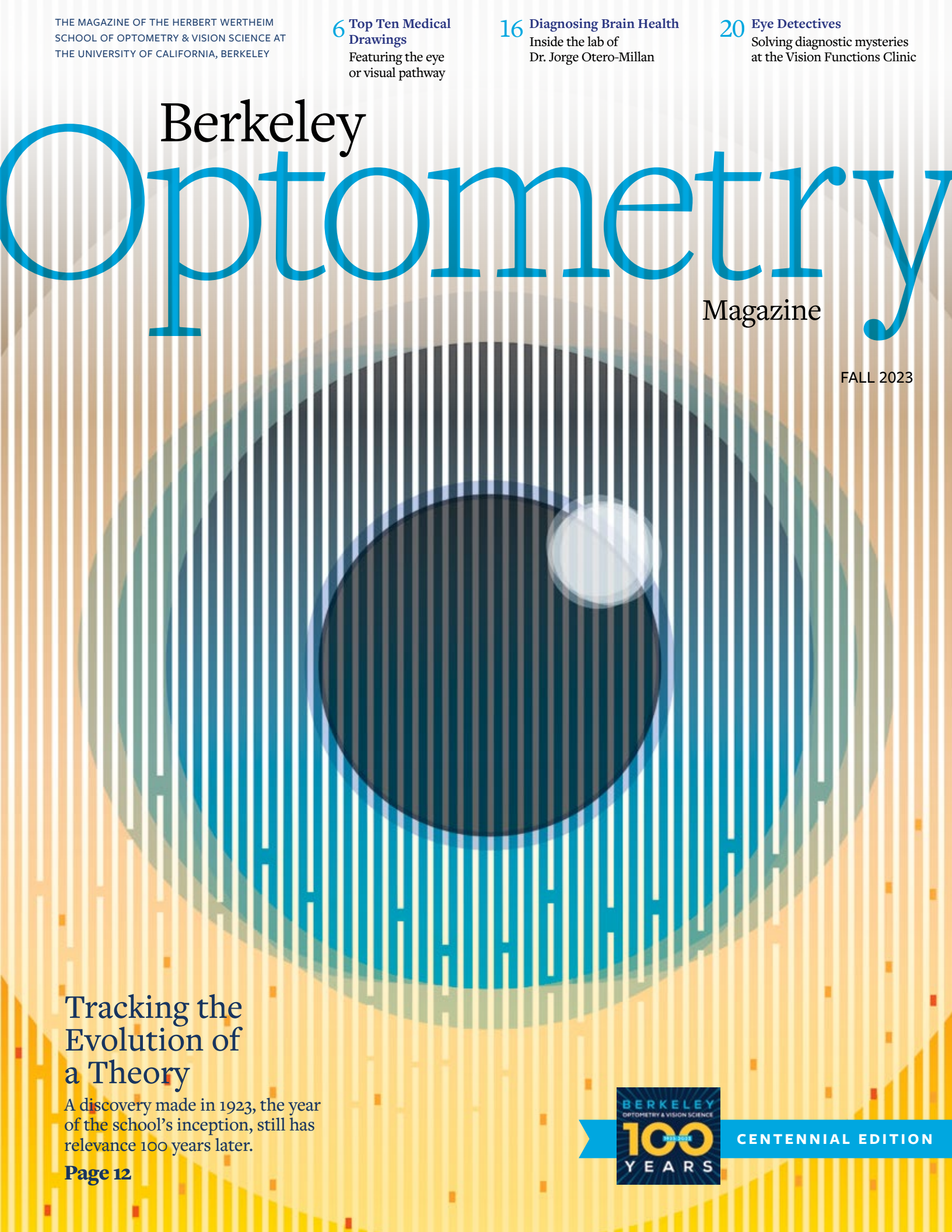
THE MAGAZINE OF THE HERBERT WERTHEIM SCHOOL OF OPTOMETRY & VISION SCIENCE AT THE UNIVERSITY OF CALIFORNIA, BERKELEY

Berkeley Optometry Magazine

FALL 2023



Tracking the Evolution of a Theory

A discovery made in 1923, the year of the school's inception, still has relevance 100 years later.

Page 12

BERKELEY OPTOMETRY & VISION SCIENCE 1923–2023 100 YEARS

CENTENNIAL EDITION

Berkeley
Optometry
Magazine

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FALL 2023

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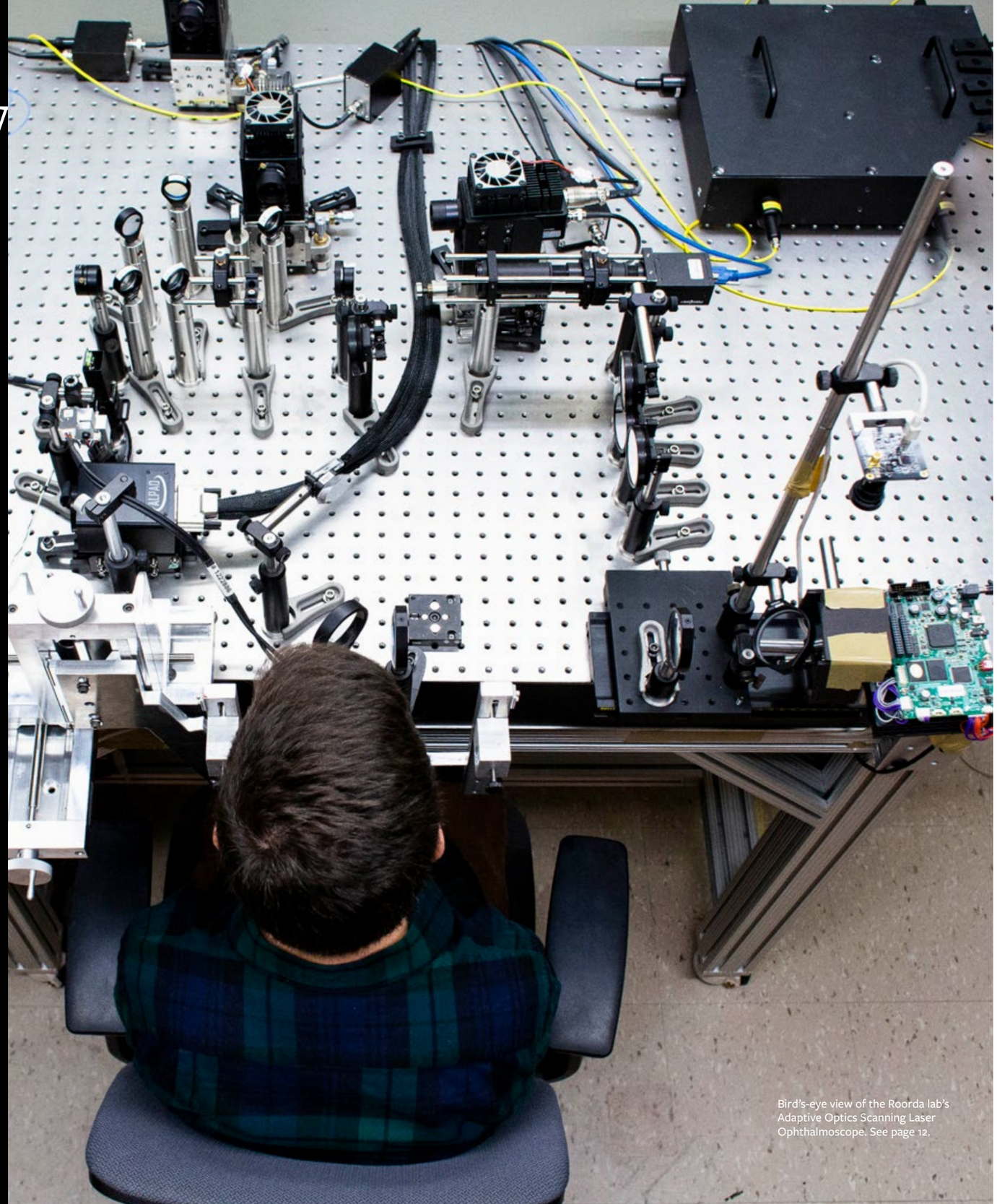


Bird's-eye view of the Roorda lab's Adaptive Optics Scanning Laser Ophthalmoscope. See page 12.

BERKELEY OPTOMETRY & VISION SCIENCE 100 YEARS

Features

COVER ILLUSTRATION BY HARRY CAMPBELL
This year's cover illustration represents a phenomenon described by Dr. Austin Roorda in our feature article, where he discusses revelations about how eye movement confers an advantage—through time. "If you get one static look at an object, it's hard to see," Roorda explains. "If you're standing still and looking through a slatted fence, for example, all you get is a little glimpse through the openings. But if you are moving past the slats, you can get a good idea of the house or garden behind it, because your eyes—and brain—have more time and more views, and the information accumulates dynamically."

OptometryNews

News from the Herbert Wertheim School of Optometry & Vision Science

Abraham Bromberg, OD '69

Alumnus of the Year

For distinguished service to the profession of optometry and to the public

Abraham Bromberg was born in México City in 1947 to parents who were welcomed by México after fleeing Jewish persecution in Ukraine and Poland. He thrived in his family's adopted county, and later earned a Bachelor of Optometry degree with honors from the Superior School of Medicine at the National Polytechnic Institute (IPN) in 1967. Bromberg received an OD from UC Berkeley's School of Optometry in 1969, and a Master of Science in Physiologic Optics from the College of Optometry, University of Houston in 1980.

Dr. Bromberg has been an academic and leader for the profession in México for over 50 years. He became a full-time professor of optometry and physiological optics at the Superior School of Medicine of the National Polytechnic Institute (IPN) in México in 1970, and later director of optometry. He was responsible for developing a new curriculum, changing the training program from a three-year to a four-year program, and the establishment of an optometry clinic. He remained at the school for almost 20 years.

Professor Bromberg also taught low vision at the Autonomous National University of México (UNAM), México's leading public research university, and has been active in organizing professional optometric associations. He is past president of the College of Optometrists of Mexico City, and the Mexican Association of Faculties, Schools, Councils (AMFECCO). Dr. Bromberg was given the responsibility by Dr. Enrique Graue, President of UNAM, for opening a new school of optometry within the UNAM system in the city of León. This was a significant and important moment for the recognition of optometry in México.

He wrote and proposed the legislative bill that finally made optometry a regulated andlicensed profession in México—first at the Chamber of Deputies where it was unanimously approved in 2013, and finally in the Senate where it was also unanimously approved. President Enrique Peña Nieto signed the bill in March 2015.

Currently, he is president of the Consejo Optometría México, a nonprofit organization that is promoting professional optometry in social media as well as continuing education. Thank you, Dr. Bromberg, for making our school shine through your commitment to the profession and to public service!

Centennial Posters Available!

In celebration of our centennial, we have created a commemorative poster. The poster, created by Bay Area artist Aldo Crusher, is now available to interested alums and friends. Please contact our alumni office at the email address listed below to request a poster-sized copy for your home or office.

optoalumni@berkeley.edu

Year in Numbers

$3,345,472
Total Giving 2023

3,782
Alumni population

662
Total donors

441
Alumni donors

$756,923
Total endowment payout

DEAN'S MESSAGE

Celebrating a Remarkable History and Shaping Our Future

What a year! What a century! Our school has seen remarkable growth, transformation, and countless achievements, all of which have been made possible by the collective talent, dedication and spirit, of our faculty, staff, students, and alumni. Each of you has played an important role in shaping our legacy.

We recently gathered together to celebrate our Centennial Reunion Weekend—our first in-person reunion weekend since 2019. We gathered in the magnificent University Club of our equally magnificent stadium, with whom we share our centennial. Fittingly, the first football victory in Memorial Stadium was in November of 1923—the year of our school's inception—when Cal beat Stanford. Chop!

We also share our 100-year history with the introduction of the first commercially available insulin, the first issue of Time magazine, the helicopter, the first diphtheria vaccine, Edwin Hubble's discovery of galaxies outside of the Milky Way, and 1923's biggest hit "Yes, We Have No Bananas." We should celebrate that the average life expectancy for women in 1923 was 58.5 years, and 56.1 years for men, but in 2023 is estimated to be 80.2 years for women, and 74.5 years for men. Progress indeed.

The Centennial Reunion Weekend saw us gather together an extraordinary group of optometrists, educators, researchers, leaders and visionaries. Six of the current nine alumni who are deans or presidents of North American schools and colleges of optometry, along with two Berkeley deans, joined our community to provide CE on the Saturday, and participate in an unprecedented panel on the Friday afternoon. We discussed their roots, their journeys, their love of the profession and thoughts on its future. The resulting video, modestly titled Visionaries of Berkeley, will be available on our website before the end of the year.

Our Sunday Golden Conference was on the topic of neurodegenerative disease and the eye. For what we believe is the first time, optometry had a Nobel laureate give a COPE approved CE lecture. Dr. Randy Sheckman (Physiol/Med, 2013), gave a riveting and highly personal account of Parkinson's disease. Equally outstanding lectures explored the scientific advances in Alzheimer's disease and glaucoma, commonalities and differences between neurodegenerative diseases, the role of neuro-inflammation, and clinical presentations informing us of how optometrists can help patients who present with neurodegenerative diseases. During the day I felt like we were witnessing the future of optometry, as we grow into the role of true primary eye care clinicians, in all of the many ways that the term implies.

Thinking back to the significant discoveries of 1923, it is fascinating to see the progress in vision science over the last 100 years. Indeed, this is a theme of our centennial magazine. In the article "Tracking the Evolution of a Theory," Professor Austin Roorda considers his own "audacious" research accomplishments with reference to Berkeley Hall of Famer Frank Weymouth's seminal and, at the time, controversial article published in 1923 in the *American Journal of Physiology* titled "Visual Perception and the Retinal Mosaic." Although Roorda didn't set out to confirm Weymouth's findings, the Adaptive Optics Scanning Laser Ophthalmoscope (AOSLO) his lab developed to track and record eye movements shows that Weymouth and colleagues' theoretical proposals were in fact true. This inspired me to look back at the *American Journal of Physiological Optics* from 1923. The editor was Charles Sheard, the annual subscription was one dollar, and it was published by the Division of Ocular Interests, American Optical Company (who said that research vs industry conflict of interest was a new phenomenon?). Articles included topics such as The Illiterate E Test, Binocular Vision and the Field of View, Problems of Lens Effectivity, Exophoria at the Reading Point, Tetrachromatic Vision and the Genetic Theory of Color, Aberrations of the Eye, and Prescribing Prisms in Ocular Practice. A true cornucopia of foundational optometric theory and practice.

As we seize this moment to reflect on the past, celebrate the present, and envision an even brighter future, I have no doubt that the next century will see us achieve even greater heights, forged by the indomitable spirit of our alumni and driven by our exceptional faculty, staff and students. It is the responsibility of the Herbert Wertheim School of Optometry & Vision Science to ensure that we drive the future of the profession with evidence, energy, ingenuity, discovery and a passion for science. I am confident that we will.

Fiat Lux and Go Bears!

—John G Flanagan

New Online Continuing Education Catalog

Offering high-quality, live and on-demand courses for optometrists

BY CATHERINE MCCHRYSTAL, M.A., M.A.ED

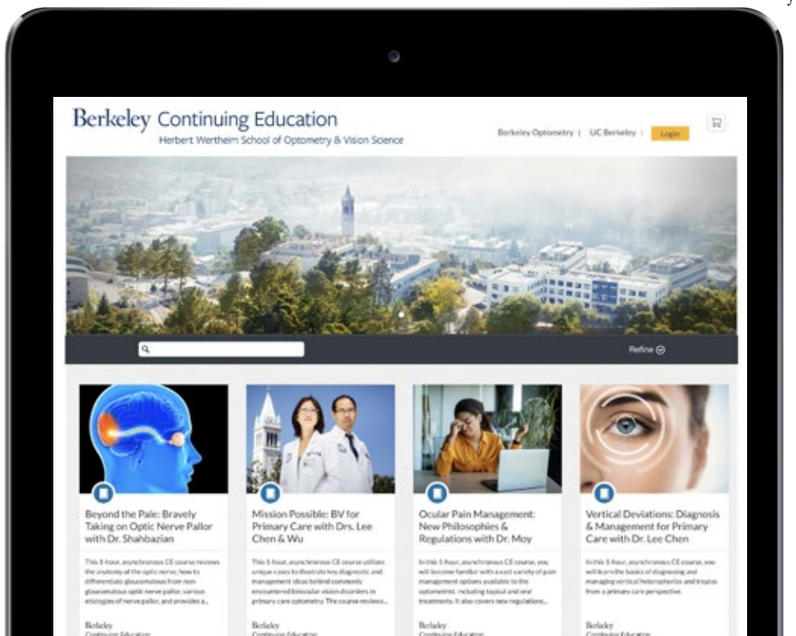
As our ever-changing world shifts to education delivery via remote instruction and distance learning, the Herbert Wertheim School of Optometry & Vision Science is leading the field of online continuing education (CE) for the profession of optometry. As part of the school's investment in online CE, the Office of Virtual Learning is launching a new online CE Course Catalog. The catalog offers a variety of high-quality online courses for optometrists to expand their knowledge and fulfill the requirements of licensure renewal by the California State Board of Optometry. The new online CE Course Catalog will expand the school's offerings of live online and asynchronous (streaming on-demand) CE courses accredited by the Council on Optometric Practitioner Education (COPE), and make them available to a national audience—enabling more optometrists to meet their licensure requirements with courses from Berkeley's expert faculty members. Our goal is to provide superior education by leveraging multimedia formats that not only engage the learner, but also provide methods by which education is more accessible. The new streaming on-demand CE courses in the online catalog will continue to uphold the quality of education commensurate with the standards of our school while providing more flexibility for optometrists to meet their licensure requirements.

We are both proud and excited to showcase our faculty expertise on a national—and eventually an international—stage. New courses from our school community will include lectures from Drs. Debora Lee Chen, Sandra Harpster, Maria Liu, Mika Moy, Pam Satjawatcharaphong, Angela Shahbazian, Mark Wu, and more! Optometrists in California and across the country will now be able to access CE on-demand whenever they need it, adding to their knowledge of specialty contact lenses, binocular vision, glaucoma, and other ocular diseases.

The "Asynchronous Virtual" courses were produced by our school staff, including our former educational technology specialist, Heather Reilly, student production assistants (Megan Lau, Phoebe Hyer, and Jocelyn Tabancay), and me, the School's instructional designer, with A/V support from Matthieu Kaminski and guidance from our CE Committee co-chairs, Drs. Pam Satjawatcharaphong and Anne Tasaki. In California, optometrists can complete 20 out of the required 50 hours of CE through asynchronous courses, and some states allow all required CE hours to be completed in this format (make sure to check with your state board!). The courses provide practical, evidence-based optometric continuing education and are self-paced—you just need to complete a post-course test to earn your CE certificate. The platform is available now at berkeleyoptometry.catalog.instructure.com—with just a few clicks, you can create an account and register for any courses you'd like to take! Once you complete the lecture materials and post-course test, you'll receive your CE certificate in your email inbox.

We'll be adding more courses throughout the year and next year, so make sure to check back often! Our CE programs are continually expanding to meet the ever-changing needs of today's optometrists. We welcome your feedback and suggestions, so please get in touch by emailing our CE Team at optoce@berkeley.edu.

berkeleyoptometry.catalog.instructure.com



Getting to Know Dr. Sam Lee

BY ELOISA MORFIN

Fourth year optometry student Eloisa Morfin talks to Dr. Sam Lee, who joined the faculty in 2022 as an assistant clinical professor.

You grew up in California, stayed in California for undergrad, and went to optometry school out of state at the SUNY College of Optometry. How does it feel to be back?

It's nice to be back in Northern California specifically since my siblings and my parents are all just a short drive away. I'm grateful I was able to live in San Diego for undergrad and New York City for several years and gain that life experience living in such different and great cities.

What do you miss the most about New York City?

I love the energy of New York City and the fact that there is always something to do, no matter your interests. I miss the convenience of everything being so close together and the ability to just hop on the subway. Even though the food in the Bay Area is great, you can't really find good bagels and pizza here.

What is your favorite thing about working as an attending at Berkeley?

The learning is nonstop; even as an attending I am consistently challenged to learn more and to be a better instructor. It's fun to work with all the different personalities and to share the knowledge I have picked up along the way.

"If you have the time and mental capacity, say yes to all opportunities that come your way as a student and at the beginning of your career."

What is one of your favorite things about the field of optometry in general?

I feel like most people talk about its flexibility, and I do have to agree. You can work part-time, full-time, or multiple jobs in different practice modalities. You can even find opportunities that don't require you to see patients! I like being involved in realms other than direct patient care and optometry gives me the opportunity to do so.

What advice do you have for students starting to pursue a career after graduation?

Getting a full-time job is very appealing after graduation, but trying different practices and modalities also has its benefits. Fourth-year rotations somewhat give you that exposure, but it is different once you graduate. You'll realize what you like and don't like, whether it's a specific subspecialty, practice modality, or boss. Then, you can add or drop accordingly and you'll be much happier.

What is the best advice you have received, either as an optometry student or after graduating?

If you have the time and mental capacity, say yes to all opportunities that come your way as a student and at the beginning of your career. Similar to my advice about trying different jobs, you never know where an opportunity will lead and how it may change the trajectory of your career for the better. If you don't try, you'll never know.

Tell me more about what research you are conducting.

With part of my time, I help with clinical research in Dr. Maria Liu's lab. I help with projects here and there—it's fun to participate in research related to myopia control, and it helps me when I see patients in that clinic. It's a hot topic and there's so much more to learn in this particular field.

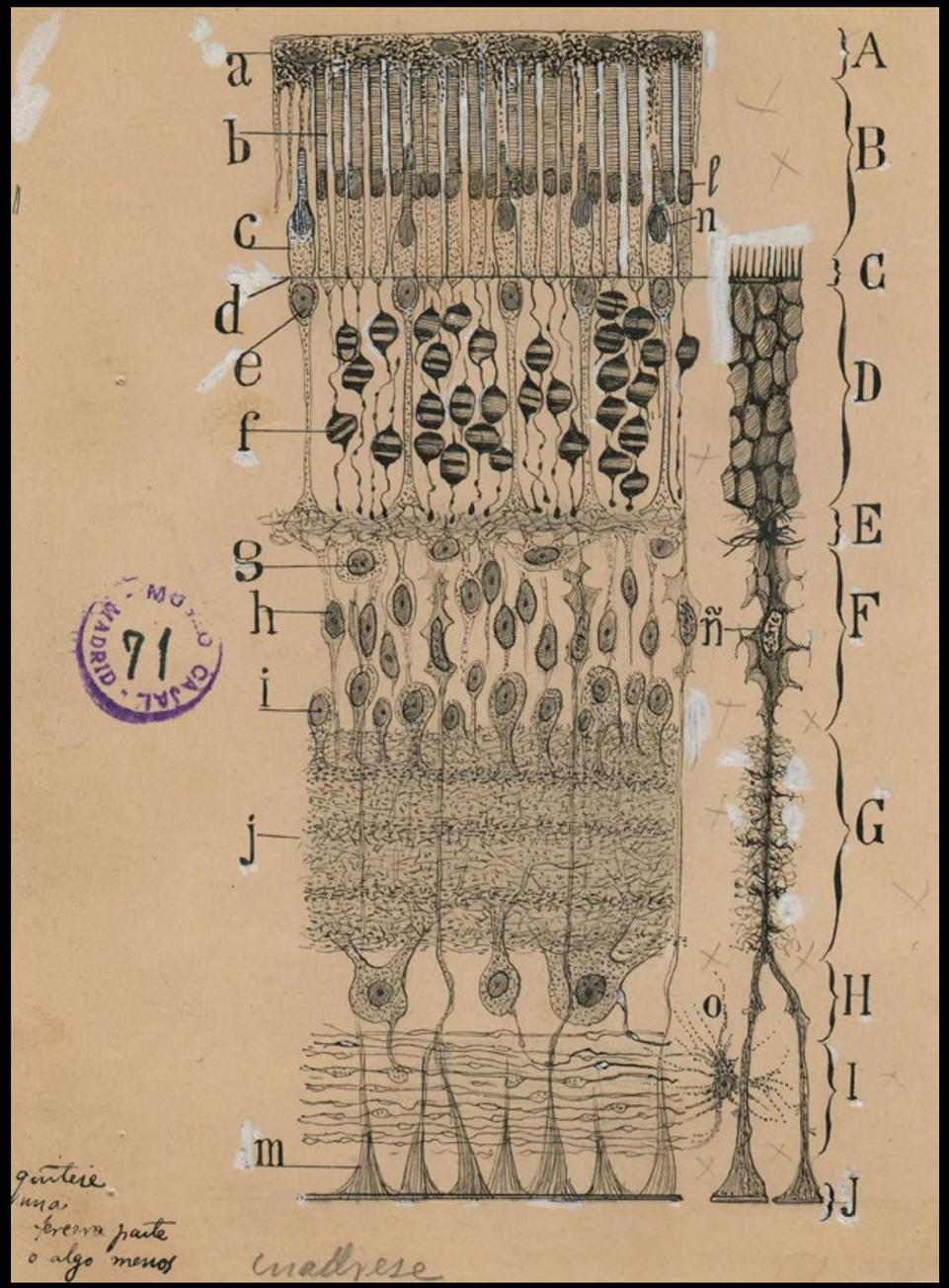
>OVERHEARD "What excites me about our new Center in Emeryville is the ability to truly approach children's vision from an interdisciplinary, collaborative, and seamlessly integrated approach that puts the child first, and optometry and vision care as the 'integrator.' We'll be able to serve children's vision needs from managing myopia control, pediatric (and adult) concussion and acquired brain injuries, sports vision enhancement, binocular vision disorders, vision related learning challenges, needs of special populations, and more; all within a few footsteps from one another. We'll be able to serve the patient, their families, and their support networks directly while simultaneously training our next generation of clinicians with this forward-thinking model of healthcare, using the latest technology."

DEBORA M. LEE CHEN, OD, MPH, FAAO
Associate Professor of Clinical Optometry
Chief Mentor, Residency in Vision Therapy and Rehabilitation
Co-Chief, Binocular Vision Clinic

Top 10

Medical Drawings of the Eye or Visual Pathway

The Herbert Wertheim School of Optometry & Vision Science turned a glorious one hundred years old this year, but doctors, artists, and philosophers have been drawing, illustrating, and painting eyes and the visual system for centuries in a quest to understand and explain how human vision works. The results can be beautiful, and amazingly accurate—but not always! The following list of images is not a ranking, but is instead a list of favorites submitted by our alumni, faculty, and students.



1>

Cells in the Retina of the Eye

Santiago Ramón y Cajal, 1904

"Cajal's drawings of the retina are as beautiful as they are anatomically accurate. Of course, at that time, photography had not matured and renderings were the best way for scientists like Cajal to share their observations." – Austin Roorda, PhD

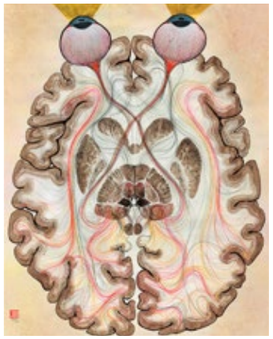
Courtesy of El Instituto Cajal, Madrid, Spain

2

Sagittal and Horizontal Sections of the Human Head

Leonardo da Vinci, ca. 1490

"Leonardo had some of the early ideas about how the eye connected to the brain—although they were a little bit off!" – Dennis Levi, OD, PhD



3

Visual System

Greg Dunn, PhD, 2022

"I particularly like this piece because it is detailed, colorful, and abstract, while representative of 'how the brain weaves visual data into and out of our attentional networks, emotional and mnemonic systems, and other senses to create our visual experience.' I also like the golden light, which looks like it could actually be coming from the eyes. – Emily Ward, PhD student

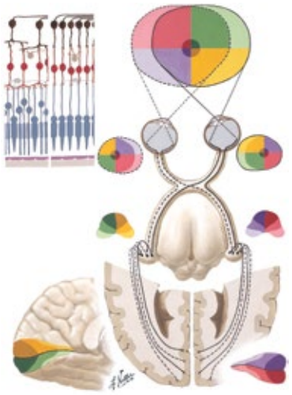
Courtesy of Greg Dunn: 22K gold, ink, marker, and pencil on paper, 24" X 32" – prints available at www.gregadunn.com

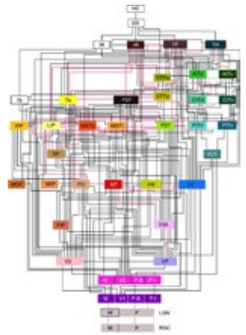
4

Schema Optic System Retinogeniculostriate Visual Pathway

Frank Netter, 1953

"Very simplified, but so elegant, and a frequent reference check for me during grad school." – Gary Walker, PhD '98



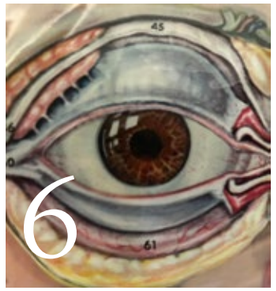


5

Monkey Visual System

Felleman & Van Essen, 1991

The visual anatomical hierarchy in the macaque monkey described by Felleman and Van Essen "shows the incomprehensible complexity of the visual system." – Gary Walker, PhD '98



Tarsal Plates and Lacrimal System from "The Human Eye"

Gladys McHugh, 1943

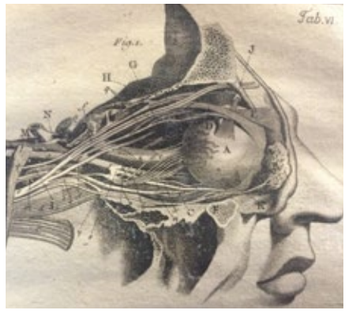
"The stereographic paintings in this book, a favorite of mine, are amazingly well done and innovative for the time—each image has eight transparencies that can be layered over the illustration to give focus on specific functions of the eye." – John Flanagan, PhD, DSc, FCOptom

7

Theory of Vision, from "Opera Philosophica"

René Descartes, ca. 1692

"Descartes argued that we see singly because there is a specialized 'fusion center' in the brain that combines the information from the two eyes (although he had it in the pineal gland!)." – Dennis Levi, OD, PhD



8

Structure of the Eye and Optic Nerves

Peter Degravers, ca. 1780

"I love the way this cutaway image of the eye and optic nerves, which is actually an engraving, reveals a stylized, fantasy-like view of the visual system's mechanics." – Anonymous

9

Eye Anatomy, from "Astronomiae Pars Optica"

Johannes Kepler, ca. 1604

"I like that Kepler shows the anatomy of the eye across different stages of dissection." – Reem Almagati, OD, MS and VS Student

10

Diagram of the Eyes, from the "Book of Optics"

Ibn al-Haytham, ca. 1200

"I like the simplicity of the drawing yet there's attention to detail like the fibers from the nasal retina crossing to the opposite side of the brain."– Reem Almagati, OD, MS and VS Student

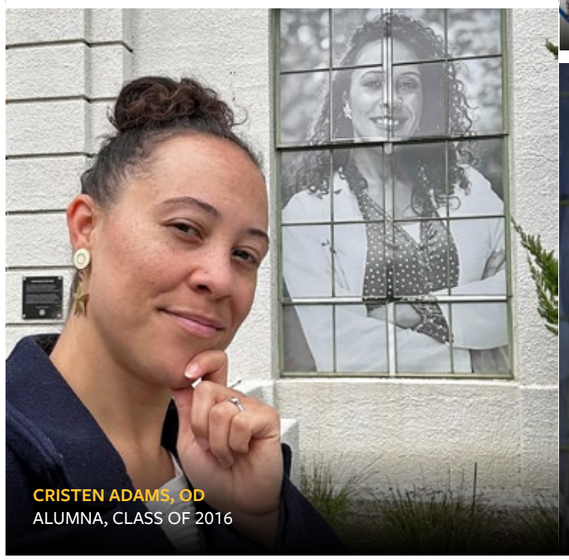
CENTENNIAL EDITION

Celebrating Our Community

A collection of photographs celebrating 100 years of optometry & vision science have been mounted on the windows on the east side of Minor Hall. As we celebrate 100 years of optometry & vision science at Berkeley, we would like to recognize and thank all the members of our community, who collectively have taken part in the success of our school. The photographs on our building represent a small fraction of the faculty, staff, students, and alumni that, since 1923, have contributed to a century-long legacy of groundbreaking research, clinical excellence, and unparalleled education in optometry and vision science.

MARLENA CHU, OD
ASSOCIATE CLINICAL PROFESSOR

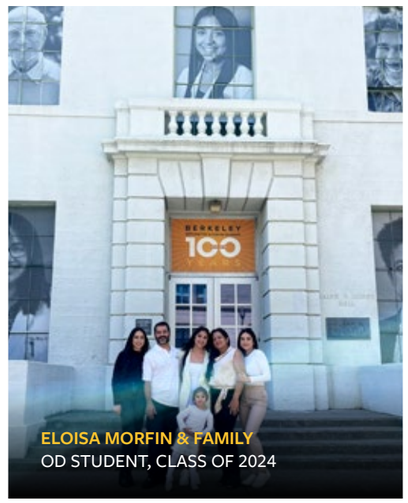
AHMAD AHMADZADA
OD STUDENT, CLASS OF 2024



CRISTEN ADAMS, OD
ALUMNA, CLASS OF 2016

ANGELICA GONZALEZ (& CLINIC STAFF)
ASSISTANT DEAN OF CLINICAL OPERATIONS

ORNEIKA FLANDRIN
PHD STUDENT



ELOISA MORFIN & FAMILY
OD STUDENT, CLASS OF 2024

JORGE CUADROS, OD, PHD
ASSISTANT CLINICAL PROFESSOR

QuickFacts

A look at the class of 2027: who they are, where they come from and how they got here.

Class of 2027

Applicants

342
Applications

224
Interviews

66
Students

Academics

3.20–4.0
Overall GPA range

3.66
Average GPA in Bio, Chem & Physics

3.7
Average GPA in undergrad

350
Average Score on the OAT

Student Profile

20
Out-of-State

45
California

20-38
Age Range

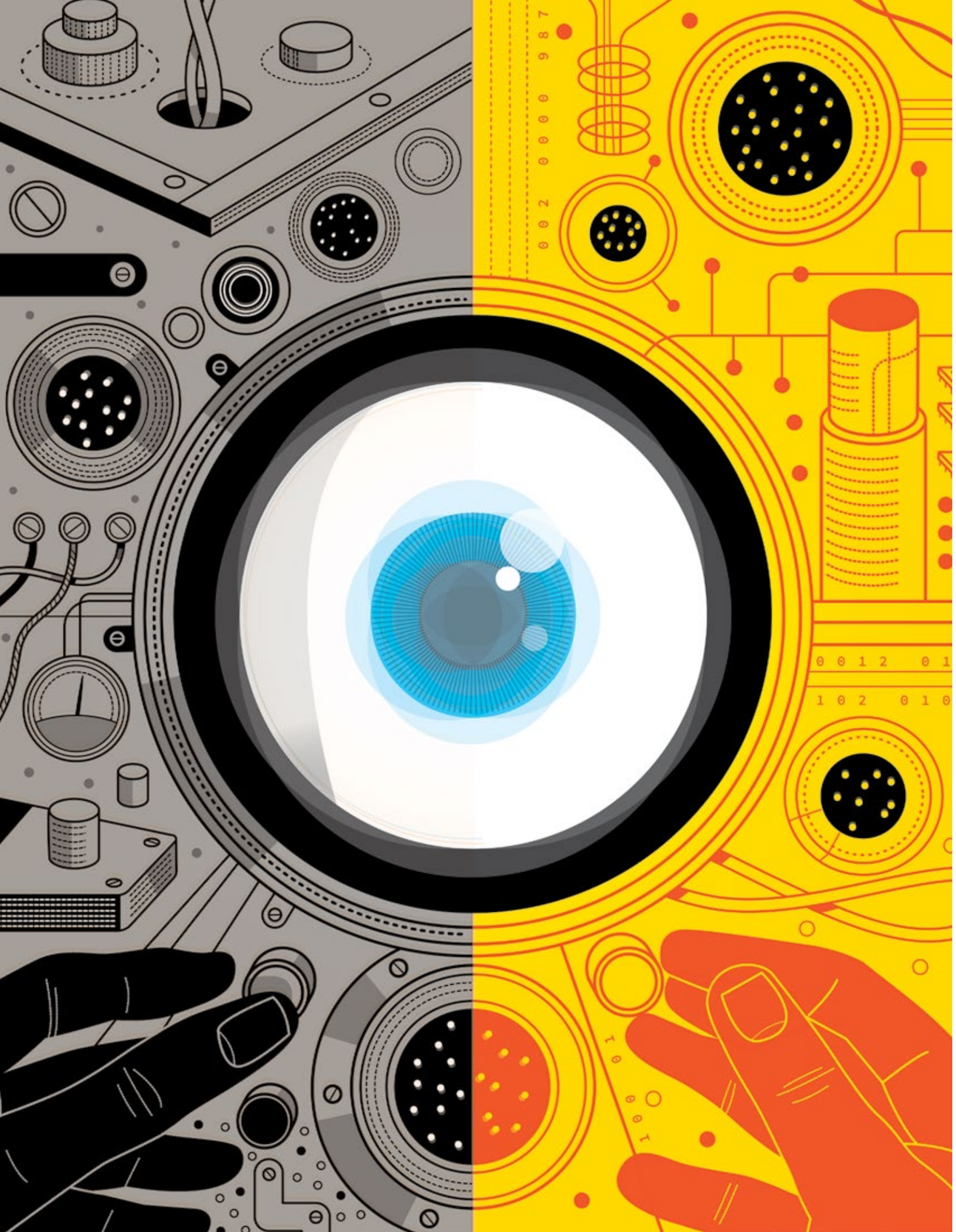
28
Number of students who entered directly from undergrad

37
Number of students who took at least a year off

14
Opto-Camp alumni

Undergraduate Institutions

CALIFORNIA STATE UNIVERSITY - FRESNO
CASE WESTERN RESERVE UNIVERSITY
CHAPMAN UNIVERSITY
CORNELL UNIVERSITY
CUNY - HUNTER COLLEGE
GRAND CANYON UNIVERSITY
HARRISBURG UNIVERSITY OF SCIENCE AND TECHNOLOGY
IDAHO STATE UNIVERSITY
KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
OREGON STATE UNIVERSITY
PURDUE UNIVERSITY - WEST LAFAYETTE
SAINT MARY'S COLLEGE OF CALIFORNIA
SAN FRANCISCO STATE UNIVERSITY
SAN JOSE STATE UNIVERSITY
SANTA CLARA UNIVERSITY
TUFTS UNIVERSITY
UNIVERSITY OF BRITISH COLUMBIA
UNIVERSITY OF CALGARY
UNIVERSITY OF CALIFORNIA - BERKELEY
UNIVERSITY OF CALIFORNIA - DAVIS
UNIVERSITY OF CALIFORNIA - IRVINE
UNIVERSITY OF CALIFORNIA - LOS ANGELES
UNIVERSITY OF CALIFORNIA - MERCED
UNIVERSITY OF CALIFORNIA - SAN DIEGO
UNIVERSITY OF MICHIGAN - ANN ARBOR
UNIVERSITY OF NORTH CAROLINA - CHAPEL HILL
UNIVERSITY OF SOUTHERN CALIFORNIA
UNIVERSITY OF SOUTH FLORIDA - SAINT PETERSBURG
UNIVERSITY OF SOUTH FLORIDA - SARASOTA-MANATEE
UNIVERSITY OF TEXAS - AUSTIN
UNIVERSITY OF VIRGINIA - CHARLOTTESVILLE
UNIVERSITY OF WASHINGTON - BOTHELL CAMPUS/SEATTLE CAMPUS/TACOMA CAMPUS
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
WESTERN ILLINOIS UNIVERSITY
WILFRID LAURIER UNIVERSITY
WILLAMETTE UNIVERSITY



Tracking the Evolution of a Theory

BY JANET WELLS

A theory proposed by a Hall of Fame researcher 100 years ago, the very year of the school's inception, has led to a path of inquiry and discovery that continues to engage and challenge the school's research community, and could potentially lead to solutions that will improve the quality of life for people with a variety of vision and brain-related disorders.

Herbert Wertheim School of Optometry and Vision Science professor Austin Roorda, PhD, hadn't thought much about eye movement until he started making images of retinas. Human eye image quality, he discovered, is "surprisingly poor."

The eye's optics are fraught with imperfections, casting an upside-down and blurred image on the retina, which is constantly moving. The eye's three types of cones are arranged in a seemingly haphazard way, and the >300 million neurons in the retina that process signals from photoreceptors are crammed into a comparatively whisper-thin conduit of axons connecting the eyeball to the brain.

As a person looking out at the world, this isn't a problem. Our visual system has evolved remarkably to tolerate imperfections and deliver a stable and detailed picture.

"The problem is when I try to look *into* your eye," says Roorda. The eye's irregularities and movements result in distortions and limited image quality from standard equipment like a scanning laser ophthalmoscope.

So, Roorda set out to design and build better tools to study the earliest stages of the visual process. In the 20 years since, he not only pioneered new technology to see more clearly into the eye, but also into what the eyes are seeing—and, in the process, helped foster an era of discovery at Berkeley.

Pushing Exploration: From Imager to Tracker

Roorda started by taking a cue from the field of astronomical imaging, which had already developed optical technology for ground-based telescopes that corrects for distortions from variables like atmospheric turbulence or temperature fluctuations.

The result? The Adaptive Optics Scanning Laser Ophthalmoscope (AOSLO). Comprised of a thicket of lenses, mirrors, and scanners, along with beam splitters, photomultiplier tubes, and wavefront sensor array, all bolted to a large perforated tabletop, AOSLO's similarity to an ordinary ophthalmoscope begins and ends with a chin rest (see the photo on the inside of our magazine cover).

Roorda credits the "heroic efforts of people in my lab and collaborators over the years" in pushing AOSLO's capabilities through several rebuilds to its current incarnation. An integrated scanning and video system not only takes images of the retina, but can also be used to deliver images to targeted locations on the retina, while tracking and recording the eye's incessant motion in real time. AOSLO's high-resolution microscopy can now peer into a retina down to the level of single cone photoreceptors.

"Improved optical techniques get sharper images. Computer technology has improved real-time calculation of eye movement, and allows us to pin images on the retina in multiple wavelengths," Roorda says. "We've effectively hacked human vision, meaning that we can bypass normal visual processes and control activity in the retina in the ways that the retina or the optics were never designed to do."

AOSLO has been a wellspring for numerous publications and awards, including a 2015 Audacious Goals

ILLUSTRATION BY HARRY CAMPBELL

Investigation: Eye Movement and Amblyopia—Chicken or Egg?

When the vital dance between the eyes and the brain breaks down, one consequence can be amblyopia.

Commonly referred to as "lazy eye" because over time the brain relies more on the other, stronger eye, amblyopia is the leading cause of vision loss in kids—more than all disease and injury put together. Its effects can last a lifetime, impacting visual acuity and depth perception.

"In people with amblyopia, their eye movements are exaggerated, constantly in motion, and they drift more. We always thought that was the cause of poor vision," says Herbert Wertheim School of Optometry & Vision Science professor Dennis M. Levi, OD, PhD. "But we've learned from
Dr. Roorda and others that normal eye movements have a purpose—to see fine detail and contrast, to get the eye where it needs to go."

So, with the goal of improving clinical treatment options, Levi and colleague Susana Chung, OD, PhD, are pursuing the answer to a "chicken vs. egg" question: Does amblyopia cause abnormal eye movements? Or are the abnormal eye movements causing amblyopia?

Using adaptive optics built by the Roorda Lab, Levi and Chung are measuring study participants' responses to visual cues in rapid succession—on the order of 1000 "tasks" per hour. "We can reverse-correlate what's happening with perception and eye movement," Levi explains. A scan can also be replayed back to the other eye, to help tease out whether the perception problem is with eye movement or some other factor—a faulty neural signal, for example.

"We're interested in understanding how much eye motion would be optimal to get the best vision," Chung says. "Eye movements are very plastic. If we understand the limiting factors on visual performance, we can devise strategies that might solve the problem and help people see better."

READ MORE about eye movements in the article on pgs 16-19.

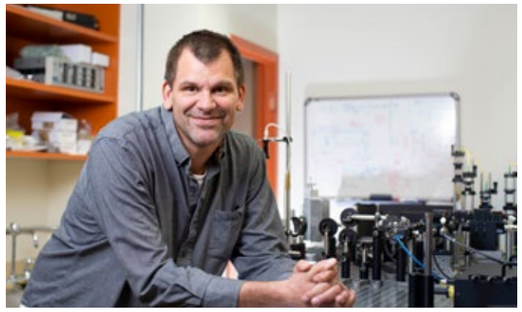
grant from the National Eye Institute (NEI) for Roorda to lead a retinal mapping project in support of an NEI long-term goal: restoring vision by regenerating neurons and neural connections in the visual system that have been lost or damaged.

Roorda's more recent investigatory trajectory into eye movement arose out of a kind of scientific kismet, following curiosity and opportunity. The original idea—for an imager that removed optical distortions—had to address eye motion, which turned out to yield "a very accurate eye tracker," says Roorda. "And that led to trying to understand the role of eye motion in vision."

The Evolution—and Resolution—Of a Theory

The eyes' continuous motion of rotating and darting has a long history of both puzzling and inspiring scientists and clinicians. Early on, the conventional—and more intuitive—wisdom was that the eyes' involuntary movements were more akin to a distracting chatter, and a detriment to seeing fine detail.

However, in 1923—the same year that Berkeley's School of Optometry opened its doors—Frank Weymouth, AM, PhD, FAAO, went against the grain, proposing in an *American Journal of Physiology* paper, "Visual Perception and the Retinal Mosaic," that very fine spatial vision is critically dependent on eye movements. Weymouth (who, after retiring from Stanford University and the Los Angeles College of Optometry, continued his research at Berkeley and is a member of the school's Hall of Fame) and his colleagues devised two innovative analog experiments to make their case.



Dr. Austin Roorda in his lab on the UC Berkeley campus.

First, they had subjects detect tiny offsets along an otherwise straight edge that was projected onto a frosted glass screen through a minutely perforated sheet of aluminum patterned to mimic an enlarged array of photoreceptor cones. The researchers simulated a moving eye by shifting the edge behind the perforated screen and a non-moving eye by holding the edge stationary. The ability to detect the minute offset was many times improved when the edge was moving.

In a second experiment, they removed the perforated screen and had subjects detect the minute offsets in the straight edge directly, this time controlling retina motion by either briefly flashing the shadow of the edge or allowing subjects up to seven seconds of continuous viewing. Just like before, eye movement was shown to confer an improvement in performance.

The initially controversial theory gained acceptance over the decades, but it remained just that—theoretical. Until AOSLO.

Roorda didn't set out to prove Weymouth et al., but "we've developed technology that allows us to revisit long-standing questions with more accuracy," he says. The similarities between their findings, he acknowledges, "are pretty striking. What Weymouth and colleagues thought might be the case 100 years ago, is for sure true."

Roorda's team reached a definitive answer thanks to their "Tumbling E Test." Projecting a tiny "E" onto the eye of a participant, researchers asked whether the letter was facing up, down, left, or right.

While AOSLO tracked and recorded eye movement, the test would be repeated rapid fire under two conditions: a "static" projection, fixing the letter in the world, which allowed it to slip around the retina with the eye's natural movements; and, a stabilized projection using adaptive optics to essentially "pin" the letter onto the retina in one position.

The findings, published in the *Journal of Vision* in 2017, showed that the human visual system has evolved to not only tolerate the eyes' incessant movements, but also to leverage this motion, which improves acuity about 25%. "When we allowed eye movements, the letter became clearer—people could see it and which direction it faced more consistently," Roorda says.

AOSLO's high-octane tracking capabilities provided further revelations about how eye movement confers an advantage—through time. "If you get one static look at an object, it's hard to see," Roorda explains. "If you're standing still and looking through a slatted fence, for example, all you get is a little glimpse through the openings. But if you are moving past the slats, you can get a good idea of the house or garden behind it, because your eyes—and brain—have more time and more views, and the information accumulates dynamically." (See our magazine cover for an illustration of this phenomenon).

AOSLO is also getting researchers closer to cracking the neural processing circuitry that underlies the benefit of eye movement. In a 2020 *Journal of Vision* paper, Berkeley computational neuroscientist Bruno Olshausen, PhD, and his student, Alex Anderson (Physics PhD), used the device's tracking data to show that by simultaneously estimating object shape and eye motion, neurons in the visual cortex can compute a higher-quality representation of an object by averaging out non-uniformities—not unlike the computational imaging principles for achieving "super-resolution" via camera motion.

From Bench Science to Clinical Care

Berkeley has become an informal hub of eye-tracking expertise with six different labs at the Herbert Wertheim School of Optometry & Vision Science currently involved with research projects related to eye movement. Several of those investigators either use AOSLO data or devices built for them by the Roorda Lab, which has also nurtured innovative technology for direct patient care (see sidebars).

"There's a growing interest in trying to understand these processes for dynamic vision," says Roorda, whose lab continues to advance basic science with AOSLO, while connecting the dots at every opportunity to clinical applications. The Roorda Lab is part of the first team, for example, to use adaptive optics imaging to monitor the efficacy of treatment for retinal degeneration—a collaboration with University of California at San Francisco (UCSF) Department of Ophthalmology Chair Jacque Duncan, MD.

AOSLO offers clinicians objective measurements of visual function—a necessary component of leveraging emerging treatments that can slow the progression of degenerative diseases, says Roorda, citing work by former student Kavitha Ratnam, PhD, who found that patients with retinal degeneration can lose 50% of their cones before they present with a significant drop in their visual acuity.

"This shows that eye movements and motion can help mitigate the effects of cone loss. It's also a warning message to doctors that you can't rely on visual acuity tests to determine the level of cone loss due to retinal diseases," Roorda says. "With AOSLO we can ask questions like, 'What is the function of that last cone at the edge of the lesion in this patient with a degenerative disease?'"

"Microscopic images of the living human eye offer cellular-level insights into how eye disease is manifest, how to slow its progression, and how it responds to treatment," he adds. "This allows us to study human vision in health and disease in an unprecedented way."

Innovation: Measuring Eye Movement for Better Health

With a background in optical engineering, **Christy Sheehy, PhD**, wanted to use her hands and "build something" for her graduate work at Berkeley. Roorda suggested a high-resolution imaging device that—unlike the rest of the lab's projects—would not use adaptive optics.

The results? A promising prototype with the potential to evaluate eye and brain health, a UCSF post-doctoral fellowship focused on clinical applications for multiple sclerosis (MS), and a start-up company that recently received FDA clearance for Sheehy's pioneering retinal eye movement monitor.

Neurologic diseases—like MS, Alzheimer's, Parkinson's, Huntington's—as well as brain injuries, retinal disease, psychiatric disorders, and even cardiac health can be examined "through the window of the eye," says Sheehy, chief executive officer and co-founder of C. Light Technologies. The company's Retitrack™ tabletop eye movement monitor records 10-second, non-invasive retinal video scans that measure fixational and saccadic eye movement at the micron level.

"Depending on the condition and the area of the brain, eye motion can be affected in a unique way," she says. "During my postdoc work looking at MS, we saw a lot of pattern changes, like nystagmus—uncontrolled, repetitive motion—or square-wave jerk intrusions." Sheehy's recent research on concussions showed microsaccades—small, jerk-like, involuntary eye movements—that are bigger and faster than age-matched controls.

Currently cleared as a general eye movement monitor with subsequent clinical interpretation, the Retitrack™ is in use by clinicians at UCSF, the University of Miami Health System, and the Medical College of Wisconsin. Sheehy sees a broad future for the technology, and is aiming for FDA clearance for the device to detect specific neurological indications. The company is also building algorithms to develop future AI capabilities for early detection and prognostication in health care.

Applying her research to clinical care has a personal element for Sheehy, who lost an aunt to early onset Alzheimer's, a grandmother to later stage Alzheimer's, and has an immediate family member with mild cognitive impairment.

"Being able to use the output of the eye as an early indicator or biomarker is huge. Neurology is decades behind, relying on surveys, memory tests, even hand dexterity and walking speed for assessments," she says. "I would love to help change neurology from a reactionary space of medicine to one that's more preventative, objective, and forward thinking."

READ MORE about eye movements in the article on pgs 16-19.

Dr. Jorge Otero-Millan sits in a gaming pod that has been repurposed for investigations into how we perceive the world while we move.

Using Eye Movements to Diagnose Brain Health

Inside the Lab of Dr. Jorge Otero-Millan

BY ZAC UNGER

Dr. Jorge Otero-Millan's lab feels like a cross between a video arcade and an underground goth night club. Everything from the walls to the door handles is painted pitch black, there's not a window to be found, and screens of various sizes are placed in front of mysterious contraptions. The centerpiece of it all is a race car simulator, complete with captain's chair, steering wheel, and three flat screen televisions, all atop a base that can move a seatbelted "driver" in any direction. "I have this here just for the 'oh, wow factor,'" Otero-Millan jokes. And while it's undoubtedly true that not every professor at the Herbert Wertheim School of Optometry & Vision Science gets their own personal carnival ride, Otero-Millan's devices are actually critical tools that have great promise for the study and treatment of multiple maladies, from post-concussion syndrome to Parkinson's disease.

We often talk about "staring intently" or "fixing our gaze" when we want to indicate that somebody is trying to get a good look at an object. But our eyes are anything but static while they work to make sense of the world around us. "Our eyes are not perfect," Otero-Millan explains, "only a little bit of our eyes see with high resolution, and if things move too fast in front of us we just see a blur." At the center of the retina is a small area of densely-packed photoreceptors known as the fovea; this area provides us with our sharpest and most acute vision. In order to send coherent images to the brain, the eye tries to keep the fovea stabilized and directed at the area of our main interest, Otero-Millan says. "But it also brings problems. Because as we have to look around, important images are jumping around in our retina," which would make it hard to walk in a straight line if the path in front of us appears to be in constant motion.

Different animals have developed different solutions to this problem. If you hold a chicken and rotate its body, for example, the bird's head will stay in one place so that the eyes can remain locked on target. Human beings evolved a different strategy, using smooth involuntary eye motions that keep the fovea directed at the area of interest, even as our heads—and the things we're looking at—are in constant motion. Whenever we want to change the

object of interest, we use rapid motions, called saccades, which are one of the subjects of Otero-Millan's research. "If you were to take a phone's camera and make a recording moving the phone like your eyes move, looking at that video would make you dizzy," he says, because you'd see everything moving all over the place. "And yet, when it's happening, you are completely unaware. It is a nice illusion that everything is stable in front of us, while in reality the retina is constantly in motion."

These saccadic motions happen constantly, often as many as three to five times per second. These are different from slow, voluntary eye motions, such as when a doctor asks you to follow her finger as she moves it back and forth. Instead, these are staccato motions: "It's a jump and then a stop," Otero-Millan says. "If I'm looking at a painting, my eyes don't do a smooth scan of everything. They do a series of jumps, and each of those jumps is a saccade. Even if you are trying to stare directly at a point, your eyes are going to be making the very smallest of saccades that you can't even notice." It's the brain's job, then, to take this scattered, disjointed information and assemble the discrete pictures into the smooth coherent movie that is how we experience our world. As an exercise, Otero-Millan has his students stand in front of a mirror, and asks them, "Focus on your left eye and then focus on your right eye, back and forth, and what kind of motion do you see?" If you try this at home you'll notice...nothing. Your brain does such a good job of putting it all together that you won't be able to detect any motion whatsoever. But look into the eyes of somebody else doing the exact same thing, and the eye motion will be immediately obvious.

"The eyes are like an EKG for the brain."

"Life without eye movements would make completing simple tasks, like preparing food or navigating from one place to another, devastatingly difficult," says Stephanie Reeves, a PhD student in Otero-Millan's lab. Without eye movements, the visual input to our brains would be unstable and shaky due to our constant head and body movements. Without saccades, "we would probably experience neck pain because we'd be moving our heads rapidly to place the fovea on areas of interest," Reeves says, "and we would experience double vision and poor binocular vision, as well." Saccades are autonomic, but even further outside our control than other unconscious functions like breathing. "We can control where we look," Otero-Millan explains, "but we can't control how we move our eyes. I can ask you to look from here to here," he says, holding up a finger on each hand, "and you can do that. But if I ask you to do it slowly, you just can't. You have some control over the general pattern, but in the end, the eyes are going to do what they're going to do."

This involuntary motion has great implications for the clinical discovery and monitoring of disease processes. "The eyes are like an EKG for the brain," says Dr. Debora Lee Chen, Associate Professor of Clinical Optometry and chief of Berkeley's Binocular Vision Clinic. "Optometrists," Chen says, "diagnose and manage many visual problems related to all kinds of neurological conditions." And this makes perfect sense when you consider that, according to researchers, over half the brain's cortex is involved in visual processing in one way or another. When there is a problem with the brain, it is often expressed in the eyes and, in particular, in the way the eyes perform the precise saccadic movement that Otero-Millan studies. "When you have a problem in that circuitry," Chen continues, "it can serve as a proxy to tell you that there's a brain problem further upstream. And it could be one point or multiple points that start directing you towards the source of the problem."

While the clinical application of using saccades to diagnose pathology is still in its infancy, there appears to be great promise. Alzheimer's disease, stroke, epilepsy, dementia, and traumatic brain injury are just a few of the conditions that Otero-Millan and his colleagues hope to better understand through their work. "The great thing about eye movements," he says, "is that they're easy to measure very precisely." Eyes can only move in three ways: up/down, side-to-side, and via torsion—a particular interest of Otero-Millan's—where the eye rotates around the central axis, the way you would turn a volume knob on an old-school radio. A person's arm, by contrast, has many more degrees of freedom along which it can travel, so measuring movements there is messy and imprecise. "The other advantage," according to Otero-Millan, "is that the eye is directly connected to the brain through fewer steps than other muscles." Additionally, different types of eye motion are associated with particular and well-differentiated locations in the brain. For example, Otero-Millan explains, "If we look at patients who may have localized lesions in the brain, you may actually get eye movements and saccades that are completely normal when it comes to smooth following, but the eyes can't stabilize when the head tilts or moves up and down." The eyes, therefore, can manifest problems in very specific brain locales, pointing clinicians towards a diagnosis. "Instead of having to ask a patient whether they can see my finger or if a light was moving to the right or to the left," Otero-Millan says, "I can introduce a measurable stimulus, track exactly how the eyes respond, and know how the brain is processing."

One of Otero-Millan's principal interests has been the study of vertigo and dizziness. When patients with these symptoms show up at the emergency room, it's important to diagnose them quickly. A large percentage of these sufferers will have a relatively common and easily treatable case of benign paroxysmal positional vertigo. "But there is a percentage of people that may actually be having a stroke," Otero-Millan explains, "and some of them may not have the other typical stroke symptoms, like arm weakness or struggling to speak. But if you do the right tests of eye movements, you can actually determine whether it's a stroke or just a problem of the inner ear." Because strokes must be treated within three hours of onset, the speed and clarity of diagnosis can have a profound impact on reducing morbidity and mortality.

Chen, who is hoping to expand on Otero-Millan's research by bringing it more regularly into the clinical setting, is excited by the diagnostic possibilities. "Classically speaking, when we diagnose brain disorders, it is a drawn-out process of neuropsychological and neurological tests that can take hours," she says. Direct brain imaging in an MRI machine can also be expensive, time-consuming, and even frightening. "We have certain patients who are brain injured or they're elderly or who have autistic spectrum disorder," she says, who can't tolerate extended time in an MRI tube. "But eye movement is so accessible and easy to capture. From a clinical standpoint, that's the dream come true."

Lab members Dr. Raul Rodriguez and PhD student Stephanie Reeves work with Dr. Jorge Otero-Millan carefully measuring eye movements.

All the devices in Otero-Millan's lab are designed to measure eye motion in various ways. The race car simulator allows a subject to be bounced around while wearing special goggles outfitted with inward-pointing cameras that track eye motion. Other devices are similar to what you might see in any ophthalmologist's office, designed to minimize head motion while the clinician—or in this case, eye-tracking software—analyzes the patient. But the most effective device in Otero-Millan's arsenal may be one that most people already spend hours a day staring into: our smartphones.

"This is in its infancy," Otero-Millan says, "but I think it's about to explode. The devices people have at their homes are going to be able to measure eye movements with more and more accuracy." Just as Apple Watches now have the ability to track our pulse and let us know when we may be having a cardiac event, we may one day be watching a TikTok video at the same time that the phone is watching our eyes, and then receive an alert that we are showing early signs of stroke or other adverse health event. And while that might sound a touch dystopian for you, using a phone as an extension of a clinician's practice has far-reaching potential. Otero-Millan foresees a day when high school athletes record baseline eye-motion data, which can then be compared to data from after a suspected concussion. On an even simpler level, a smartphone can instantly transport the clinic to the living room. "Symptoms can be frustratingly sporadic," says Chen, who sees hundreds of patients a year in her office. "Patients will say that they felt terrible, that everything was spinning, but then when they arrive for their appointment, everything is fine on that day." Otero-Millan is developing software that can be downloaded as an app, which would allow patients to monitor themselves over long periods of time or simply record their saccades at the precise moment their symptoms become acute. "We can incorporate all of this with AI and machine learning," says Otero-Millan, describing how computers can learn to recognize signs and symptoms of disease by comparing individual results to massive databases. "Computational modeling will assist us with diagnosis and a better understanding of how the brain functions."

The science of eye tracking is of particular interest to tech companies, who not only want to know precisely where their users are focusing their attention, but also need to interpret how saccades work in order to make virtual-reality successful. "If you want to understand why those [virtual reality] headsets make people nauseated," Otero-Millan says, "you need to understand how the brain interprets motion, how we perceive things as being stable or not."

Despite the commercial potential for his work, Otero-Millan remains committed to the clinical applications and the potential for making life easier for those suffering from diseases. "He doesn't come from a clinical background," says Chen, "and yet he has such a clinical eye, combined with a vantage point and a multidisciplinary perspective that will eventually be so valuable to our patients." As for Otero-Millan himself, his dreams are even more expansive: "I want to create a full model of how the brain controls our eye movements," he says. "How does the brain know if the eye has moved or the world has moved? Once we have that model, we can change any little piece of it and truly understand what our patients are experiencing. That model will be the ultimate diagnostic tool."

Eye Detectives

Dr. Emily Gorski and the Vision Functions Clinic solve diagnostic mysteries

BY GORDY SLACK

The Vision Functions Clinic (VFC) is no noir, wood-paneled, 12th-floor detective's suite dotted with overflowing ashtrays. It's bright and open, modern, and clean. Smoking is verboten. Nonetheless, Emily Gorski, OD, the clinic's chief, does see her mission as something like that of a private eye, bringing both investigative technologies and her own determination and deductive powers to bear on difficult-to-diagnose cases of faltering vision.

When vision works, it seems so simple: the world is just there for us to see. But when it fails, vision's complexity becomes acutely apparent. While a general practitioner or optometrist can check many potential explanations for vision problems by simply examining the eye, if the cause isn't visible, a deeper level of inquiry may be necessary. So Gorski, an assistant clinical professor of optometry, deploys electrophysiology to track down evasive diagnoses at Berkeley's Vision Functions Clinic. Most of her patients have been referred by primary eye care providers unable to identify the nature of their patients' blurred vision, night vision problems, or excessive light sensitivity.

> "Locating the nature of the problem can validate the patient's experience, even if the condition cannot be fixed."

Formed nearly three decades ago, the VFC is specially equipped to interrogate the functioning of the retina and the optic nerve, and hence to identify various retinal and visual pathway disorders. The clinic's two gravitational centers are, first, an electroretinogram (ERG), a machine used to measure the electrical activity of the retina in response to light stimulation, and second, Gorski herself, who took over as clinic chief in 2019. She is trained specifically to use the ERG and the clinic's other electro-sensitive testing devices, and to interpret their results.

By locating and reading electrical signals emitted from groups of cells firing in the retina, the ERG enables clinicians to evaluate patients for retina-related conditions and to reliably monitor retinal function over time, helping to evaluate the efficacy of—and to fine tune—retinal treatments. "The ERG shows objectively how the retina is functioning so we can figure out what's really going on at the cellular level in the most puzzling cases," Gorski says.

Administering the test

First, Gorski uses eye drops to dilate the patient's pupils and to anesthetize their eyes. She then puts the patient in a dark room so their retina can dark-adapt, before painlessly placing an electrode (embedded in a contact lens) on each of the patient's corneas.

"The electrodes record the electrical activity generated by the retina in response to various flashes of light," says Gorski. "We then record responses in a similar manner under light-adapted conditions. From the recordings, we can determine the health of the cones, rods, and other retinal cells."

The retina's responses, as measured by the ERG, are expressed as waveforms corresponding to different stages of retinal processing, including the a-waves (primarily generated by photoreceptors), b-waves (largely generated by bipolar cells), and other components that reflect the complex interplay of different retinal cell types.

A roadmap for patients and their doctors

The test results help Gorski zero-in on retinal and visual pathway disorders that would otherwise be invisible. Her clinic patients divide into two main groups: The first is children or teens whose eyes appear to be fine, but who are suffering from reduced central vision, bad night vision, or some other symptom that is affecting their quality of life. Typically, the referring doctor suspects an inherited retinal dystrophy, evidence of which just may not be yet visible.

"The most common inherited retinal dystrophy we see is retinitis pigmentosa," says Gorski. "And that can affect people at any age, but we see it most commonly in our young patients—a parent brings their child into the clinic after noticing that they don't see well and are bumping into things at night, for example, even though a visual inspection of their eye looks okay," she says. "If the ERG reveals dysfunction of the night-vision-sensing rod photoreceptors, then we'd send the patient for genetic testing to zero-in on an etiology." In other words, and to paraphrase detective fiction writer Raymond Chandler, this helps determine if the streets really are dark with something more than night.

The second type of patient is older but also has visual symptoms with unexplained cause. "A patient may experience a significant decline in their night vision, difficulty with light-dark adaptation, or perhaps central vision loss without any visible cause. Or they may experience other disturbances in their vision, like visual snow" (static-like white dots in the vision), says Gorski.

"Electrodiagnostic testing can help localize the problem and give us a sense of the level of dysfunction occurring in that area. This helps direct what additional tests are needed to reveal the diagnosis, which might include additional labs for systemic diseases, MRIs of the brain, or genetic testing. For example, if an inherited retinal dystrophy is suspected, we will recommend genetic testing, and the ERG will provide context for interpreting the results and giving us a better idea of prognosis."

ILLUSTRATION BY PAUL BLOW

Visually Evoked Potential (VEP)

Null results from retinal tests suggests the problem may lie further downstream in the visual system, and Gorski can follow such leads with a Visually Evoked Potential (VEP) test, which assesses the conduction of visual signals from the retina through the optic nerve and to the various visual processing areas of the brain.

The patient taking the VEP has their scalp fitted with electrodes and is presented with visual stimuli, such as patterns or flashing lights, while the electrodes pick up the electrical signals traveling through the optic nerve to the visual cortex in the back of the brain. Gorski analyzes the speed and strength of the signal conduction to glean more valuable clues about the functioning of the optic nerve. If she identifies a problem there, she is likely to refer her patient to a neuro-optometrist or a neuro-ophthalmologist.

Helping patients navigate the best way forward

More often than not, Gorski is delivering tough news to her patients and their doctors. If they have made their way to her clinic without a diagnosis, their conditions are likely to be systemic and degenerative. Retinal dystrophies are the most common conditions her detective work reveals. Cone dystrophies are not uncommon. Stargardt disease is another condition that she too often sees. These diseases may not be curable, but accurate diagnosis is key to ensuring patients can undergo the best available treatments or adopt the best mitigations to maintain their quality of life. What's more, when a patient experiences a symptom, say very poor night vision, but can't find an explanation, that can be very demoralizing. "Locating the nature of the problem can validate the patient's experience," says Gorski, "even if the condition cannot be fixed."

"Although many of these retinal issues don't have treatments or cures, often, we can still help by getting the patients the rehabilitation or just the prognosis that they need," says Gorski.

Sometimes a clinic visit does reveal information that helps a patient recover lost vision or avoid further harm. For example, Gorski sees cases of retinal inflammation, where early diagnosis helps avoid permanent damage, and treatments such as intravitreal injections or systemic medications may help improve the problem. She also tests patients taking medications for unrelated conditions that may cause retinal damage. "We're able to monitor these patients closely so that if they develop a toxicity, we can end the medication course before they even have visual symptoms of it. We're able to save them from a sight-threatening condition. That's very gratifying!"

In some cases, Dr. Gorski refers patients with intractable retinal or optic nerve conditions to clinical trials, which may help those patients as well as advancing knowledge in the field. She has high hopes that, for example, as emerging gene therapies mature and become available to her patients, many of the inherited retinal dystrophies she now diagnoses will become treatable. "With treatment options for these conditions, early diagnosis with ERG testing will be all the more critical," she says. And more of the tough and hard-to-crack cases she investigates will have a clearer resolution.

WhereAreTheyNow

Our recent grads are out in the real world making a big impact. See where they ended up.

Aubrey Vetrone, OD, Class of 2020

Where are you living now? Sacramento, CA

What are you doing now for work? After graduating in May of 2020, my husband (Vincent), first born son (Kayden), and I welcomed our first baby girl (Eliyana) into our family in June of 2020. I enjoyed 6 months with her and began working part time in November of 2020. I started my career as an optometrist at a busy private practice in Elk Grove, CA, called Crystal View Optometry. After being there for a while, I decided I wanted to experience working in different types of private practice settings. So I started some fill-in work with both a private practice located within a Target, and the small private practice that helped kickstart my optometry journey, called Wang Optometry. I began working full time at Crystal View Optometry in the beginning of 2022 and occasionally filled in, when needed, with Wang Optometry. However, with another baby girl on the way, I am entering maternity leave, but when I return I will continue to work with both offices.

What is the web address for where you work?
crystalviewoptometry.com

What bit of advice or wisdom would you have for students just starting their OD Program? My biggest piece of advice for any and all Opto students is to take it one day at a time! Optometry school throws A LOT at you... whether it's educationally, socially, mentally...etc. The education program is tough, but I have been using the clinical information from the moment I stepped foot in the clinic for rotations. The social experiences such as attending some of the different events the school put on allowed me to get to know my professors, classmates, and other Optos not in my cohort/class (such as my sib family) even better than I would have by simply attending classes. Additionally, it was a huge bonus that my classmates and I became a family and were supportive of one another from day one. It's not an easy journey by any means, but I will say it's worth it! I love my career and appreciate all the experiences I had while at Berkeley!

Katherine Makedonsky, OD, Class of 2017

Where are you living now? San Carlos, CA

What are you doing now for work? I work for Verily, a Google created start-up. I'm the clinical lead on a retinal camera intended to be used by primary care physicians. The goal is to conduct a retinal screen for people who have diabetes while they are in the primary care doctor office and refer to an optometrist or ophthalmologist if pathology is identified. I work with software engineers, hardware engineers, user experience designers and product managers to ensure that our product operates successfully while ensuring a seamless usability. I like that every day at work is different, and that I get to experience all the Google offices and their perks! One day a week I still do see patients at a private practice in Los Altos. This keeps me current and connected.

What is the web address for where you work? verily.com

What bit of advice or wisdom would you have for students just starting their OD Program? Patient care is extremely rewarding, I recommend approaching the optometry program with excitement because you love the patients. Working in industry is very niche, and may be worth exploring after you gain experience as a doctor.

Laura Carter, OD, MPH, Class of 2022

Where are you living now?
Richmond, CA

What are you doing now for work? I see patients full time and I love it! I am one of three optometrists at a new eye clinic started last year at the Petaluma Health Center, and I'm so lucky to be here. It's a National Health Service Corps site in Sonoma County that serves primarily Medi-Cal covered and uninsured patients. The clinic is nationally recognized for being an excellent place to work and the staff I work with are absolutely amazing. I also get to really practice my Spanish everyday.

What is the web address for where you work?
phealthcenter.org

What bit of advice or wisdom would you have for students just starting their OD program? Find balance in your study habits early on. Have at least one fun activity planned every week that you can look forward to throughout the semesters. Something to keep your motivation and spirits high when the program gets tough, which it definitely will. Aim not for perfection but for perseverance and well-roundedness. And keep a good sense of humor.

Vasha DuTell, PhD, Class of 2022

Where are you living now? Cambridge, MA

What are you doing now for work? I did my thesis work with Bruno Olshausen and Marty Banks building a head-mounted eye tracking system to study the statistics of human vision in the wild. I'm currently doing a postdoc at MIT CSAIL as an inaugural fellow in the METEOR Fellowship program. I'm co-advised by Ruth Rosenholtz and Bill Freeman, working at the intersection of human vision and computer vision, where we are using machine learning to improve current models of peripheral vision. This summer, I'm participating in MIT's delta v accelerator program founding a startup in mental health/wellness and AI.

What is the web address for where you work?
csail.mit.edu

What bit of advice or wisdom would you have for students just starting their Vision Science PhD program? My advice for students just starting their PhD is: 1) Make sure you absolutely LOVE whatever project you are working on—you'll need that passion to get through the long journey to graduation; 2) Everyone (yes even the professors!) experience imposter syndrome—always remember that you do belong here; and 3) Take your physical and mental health seriously, even if you are optimizing for productivity alone; taking care of these basic needs is always worth the investment.

Leading the Way

John, Chris and Monica talk about their vision for the school's future as the Herbert Wertheim School of Optometry & Vision Science embarks on a second century of excellence.

What is your vision for the school?

John Flanagan: Our ambition is to lead the profession. To make this happen, we are embarking on an ambitious and unprecedented period of growth. Our vision includes a new satellite campus in Emeryville that will offer optometry-led, interdisciplinary children's eye care and vision health; the Academy for Advanced Optometric Education; an expansion of our residency program; establishing clinics at other UC schools; creating new teaching spaces that will feature clinical skills labs where students can practice basic as well as advanced techniques; a clinical trials research center; and increasing the number of fellowships for PhD students in the Vision Science Graduate Program.

Why did the school choose Emeryville for a new clinic?

Monica Porter: The Emeryville site was donated to the UC Berkeley campus—an estimated $17M value. The campus will provide use of the space rent-free for the life of the building. Space constraints at our current clinics have hindered our ability to expand high-revenue generating specialty clinics, such as Sports Vision, Neuro-Rehabilitation and Myopia Control, and expansion of our professional continuing education programs. The Emeryville site's 39,400 gross square feet will allow the expansion of these clinics and programs to include 40 exam lanes, therapy rooms for sports vision and BV, a retail eyewear center, and an academic center for continuing education.

How is the Emeryville project being funded?

Monica Porter: The funding for this project is coming from a variety of sources. A generous seed gift of $10m from the Wertheim Family Foundation—part of the $50m donation from the Wertheims—and the $17m in-kind gift from the campus, described above, as well as a $10m commitment from the school as part of the ongoing "Our Future, Our Vision" campaign, form the bulk of the project's funding.

When will the new Emeryville clinic open?

Monica Porter: We expect the new clinic to open in late 2025.

What services will be offered at the new Emeryville clinic?

Chris Wilmer: The new Emeryville clinic will double our clinical capacity, expand opportunities for world-class education and research, and advance an exciting new model for integrated pediatric optometric care. More specifically, it will offer basic and advanced eye care service and treatment for adults and children; specialty pediatric eye care, including infant, toddler, and children's clinics; special vision assessment clinics; binocular vision clinics; vision therapy and rehabilitation; a concussion clinic; a low vision clinic; a contact lens clinic; a myopia management clinic; a sports vision clinic; and a state-of-the-art eyewear center, all under one roof.

How will the new clinic benefit the community?

Chris Wilmer: Our mission has always been to care for the community. The emphasis on pediatric vision care will provide access to expert eye care from top notch doctors, residents and interns, for our youngest patients and their families. I am excited to welcome the Bay Area community to our newest clinic, and look forward to delivering the kind of world-class primary and specialty vision care that can improve the visual and functional lives of our patients.

How will the new Emeryville clinic benefit students?

Chris Wilmer: We are proud of the opportunities and training that our students are currently receiving—our faculty are best-in-class, and students are exposed to specialty clinics that provide a vast array of unique, cutting edge optometric care. However, we are limited by our existing physical space. The Emeryville clinic will provide students increased exposure and training for pediatrics and children's vision, especially in areas related to binocular vision, sports vision, neuro rehabilitation, myopia control, and low vision. Our hope is that these increased opportunities will provide a richer experience for our students.

How will the new clinic support the profession?

John Flanagan: The new clinic in Emeryville will include a center for professional education that we are calling the Academy of Advanced Optometric Education. We'll use this space to host continuing education events, lectures, and seminars that are designed to be hands-on, and workshop-based small group learning. Our goal is to provide a dynamic learning environment for optometrists to enhance their skills and stay at the forefront of their profession.

> **"The new Emeryville clinic will double our clinical capacity, expand opportunities for world-class education and research, and advance an exciting new model for integrated pediatric optometric care."**
> CHRIS WILMER

Will the Emeryville project adhere to sustainability best practices?

Monica Porter: Yes, this is an important consideration. The construction project will comply with the UC Policy on sustainable practices, including achieving LEED-ID+C Gold standard, and capping the existing natural gas supply to comply with the university's de-carbonization goals.

Will there be renovations at the Meredith Morgan University Eye Center?

John Flanagan: Yes, we have an acute need for renovations to our campus clinic, but the challenge is that our clinics are too busy to renovate. We don't want to shut down any of our clinics during renovation, or displace any of our patients, so an emerging solution is to build the new clinic in Emeryville, then shift some our our speciality clinics there on a rotational basis so that we can free up and repurpose some space at the campus clinic for renovation.

How is the school training students to meet the eye care needs of marginalized communities?

John Flanagan: Healthcare disparities continue to impact many marginalized communities, and it is vital that our students are equipped with the knowledge, skills, and attitudes needed to appropriately meet the eye care needs of our communities. To help provide this knowledge base, we have introduced tools—with the help of Dr. Ruth Shoge, Director of DEIB and Associate Clinical Professor—that our faculty can use to evaluate whether their courses are addressing societal expectations for diversity, inclusion, justice, and anti-racism. This is a change that is happening throughout our curriculum. One example is the problem-based learning course in the second year, where students work through real cases and consider current health care disparities for each of the clinical conditions studied.

Is it true that the school plans to move to a satisfactory/unsatisfactory grading system?

John Flanagan: Yes, we are very excited about this change! We have received permission from UC Berkeley's Academic Senate to become the first optometry program in North America to move to a satisfactory/unsatisfactory grading system throughout the entire curriculum. This is common in medical schools, but has not previously been offered in optometry programs other than in some clinical courses. We think this change will be a significant benefit to our students. An important development in professional health science education has been to try and de-emphasize the competition within a cohort. Removing the competition for grades will allow students, we believe, to learn to be professional colleagues as part of their education, to respect each other's unique gifts and abilities, and will put more of an emphasis on what each individual needs to learn to become the best optometrist they can be. I'd like to make clear though that the new grading system isn't intended to reduce the hard work and intensity of focus required for becoming a good doctor, but we want it to eliminate the feeling that you need to be competitive with your peers to get there. This will be introduced in the fall of 2024 to the first year class, so will be fully operational across all classes by 2028.

Will any new courses be added?

Chris Wilmer: Yes, we are introducing two new modules for our 200 series—our clinical lab courses—for the 2023-24 academic year. The new modules concentrate on in-office laser and minor surgical procedures. We also will be offering a new course called Health Economics, Law, and Policy (HELP), which is an introduction to the health care system and the challenges we currently face as a nation in providing affordable, accessible, and high-quality care to patients. Several outstanding guest speakers with expertise in public health, health policy, sustainable community health, infectious disease, DEIB, and artificial intelligence will participate to share perspectives and ideas that will guide our next generation of health care providers.

What is your vision for the future of our residency training program?

Chris Wilmer: We would like to expand our residency training program. Residency training is important in a number of ways. It's a great way to develop expert doctors, trained in specialties such as pediatrics, myopia control, or sports vision—just to name a few—who can then go into a community practice or join our faculty here at the school. In this way, it's a huge benefit to the profession, and it's important that we contribute to that. Residents also play an important role in serving our patient's needs here at our own clinics. But expansion needs to be done carefully. We need to ensure that it's sustainable and that we are providing a rich experience for our residents. As the Emerville clinic comes online, we anticipate that we will be able to leverage the increased space to add more residents in the specialty areas. We also can imagine placing residents at other UC schools as a way of expanding our off-campus residency opportunities.

AlumniNotes

We've tracked down some of your favorite classmates. Here's what they're up to.

1960

1 | Lee Goldstein, OD '66
Dr. Goldstein drove the length of Baja California from Mexicali to La Paz and back; touched whales in San Ignacio Lagoon; led an off-road group through the Great Basin in Nevada; traveled to Scotland; and chaired Earth Day in Laguna Woods!

1970

2 | Michael Clark, OD '73
Having always enjoyed the the great hiking available in California, early this summer, Dr. Clark decided, along with a close childhood friend, to explore the verdant pastoral landscape of Western Ireland. The pair decided to hike the lesser known and more manageable Kerry Way in southwestern Ireland. The 140 mile 8 day hike spans some of the most rugged terrain of this small island nation. Like California, it also offers some of the most spectacular interfaces of land and sea.

3 | Larry Thal, OD '75
In 2023 Thal Vineyards won a gold medal, two silver medals and a bronze medal in the California State Fair! The vineyard, started by alum Larry Thal and his wife Esther, was created in 2010 as a solution to a worsening erosion problem on the steeper slopes around the Thal home on 14 acres in Lafayette. Due to grape vines having strong and deep roots, their tolerance for minimal irrigation and their resistance to fire, this seemed like a perfect solution. Larry and Esther's appreciation of good wines led them to UC Davis for assistance in analysis of soils and climate and to the eventual decision to plant Cabernet Sauvignon, Merlot and Sauvignon Blanc. Together with local winemakers they bottle an award-winning Cabernet/Merlot blend, a straight Cabernet Sauvignon and their limited production but signature Sauvignon Blanc. With nearly 2,500 vines they are one of the largest vineyards in the Lamorinda area. More recently Larry and Esther undertook the construction of a local winery and tasting room on Mt. Diablo Boulevard. The intent of the tasting room is to allow growers and winemakers to showcase the truly outstanding wines made locally.

Hey Alumni!

Do you have a story to tell? About your career or your life? We'd love to hear from you! Send us pics and details.

optoalumni@berkeley.edu

Please visit our website to see more updates from our alumni!

optometry.berkeley.edu/alumni-notes

Page Yarwood, OD '76
While enjoying semi retirement after 35 years with the Kaiser Permanente Medical Group, Dr. Yarwood is currently on the Alameda Contra Costa Counties Optometric Society Board of Directors serving as co-director of legislation. Page also stays active as a volunteer and art docent at the Oakland Museum of California, and is following her passion of collecting early California Impressionist paintings and photography.

1990

4 | Brent Chinn, OD '92
Dr. Brent Chinn currently works in private practice at Precision Eyecare Centers in the South Bay. He shares his practice with fellow alumnus David Redman, Jessica Vu, and Linh Le. In April, he did us all proud as a contestant on Wheel of Fortune!

5 | Susy Yu, OD '96
Dr. Yu was appointed to the board of directors for Optometry Giving Sight, a philanthropic organization that supports projects focused on building sustainable and scalable optometry-led programs that educate eye care providers locally and enable the establishment and delivery of vision care and eye health to all. Eyecare is Healthcare! Based on the photo she submitted, she is also quite adverturous!

2000

Jennifer Hsieh, OD '09
Dr. Jennifer Hsieh is a private practice owner with six wonderful employees. Her office is at Almaden Valley in San Jose. She is passionate about myopia management and has provided care for many children as well as fitted them with OrthoK and MiSight contact lenses. Her office is one of the top practices in the country for fitting patients with MiSight contact lenses. In her spare time, she likes to spend time with her husband and son and go on their weekend adventures.

2010

6 | Sheryl Reaves, OD '11
Dr. Sheryl Reaves is is currently an optometrist at Jessie Trice Community Health Center, serving Miami's historically Black communities. She also serves on our school's Alumni Board. She shared this photo of her daugher Shelby's first birtday party. Also picutred is her husband Dorian Sr., and her son Dorian Jr., age 4.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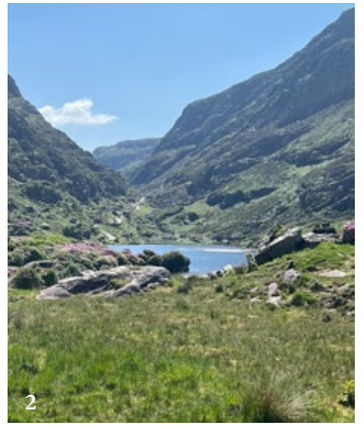
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7 | Daphne Chan, OD ’13
Daphne joined the UCSF Department of Ophthalmology in 2015. She is associate chief of optometry at UCSF and a fellow of the American Academy of Optometry. She serves as secretary of the San Francisco Optometric Society as well as the Bay Area Optometric Council. Daphne enjoys trying new foods, organizing events, watching Marvel movies, traveling, quoting and making references to the Harry Potter books, singing in the car, and spending time with friends and family, where she has gained the title of Favorite (and only) Auntie to her two nieces and one nephew. She talks shop with her optometrist dad (Alan Chan, OD ’72), and she shared fond memories of a recent VOSH trip to Jamaica, where she had the opportunity to provide free eye care alongside current students and fellow Berkeley alumni.

8 | Calista Ming, OD ’16
2023 has been an amazing year so far for Dr. Ming. She took full ownership of her practice, Premier Vision Care Optometry, in Lomita, California—a private practice focused on speciality contact lenses. She also had the privilege of being a Key Opinion Leader for Bausch and Lomb, helping educate and train optometry students and fellow optometrists in scleral contact lenses, and through the STAPLE Program, Calista helped to educate third year optometry students on soft toric and multifocal contact lenses. She is very excited to return to Berkeley in July to work with the current third year students. Besides her professional roles, Dr. Ming’s biggest title is “Mom” to her almost three year old boy and one year old daughter. Calista says this couldn’t all be possible without her husband, with whom she recently celebrated a 5th anniversity in Bora Bora!

9 | Sloan Rajadhyksha, OD ’17
Dr. Rajadhyksha got married in June of 2021 and moved to San Diego, CA to open an optometry practice. Within 6 months she and her husband took over two optometry practices in north county San Diego from retiring doctors. She says, “It’s been an absolute adventure! We are currently in the process of expanding our first location to twice the size it is now. We are very excited to see what the future holds for our practice!” Over the last two years they have traveled to Costa Rica and Portugal, and plan to go to Paris this year for Ryan Ngo’s (her best friend) wedding. Ryan was a fellow classmate at Berkeley! She has also become an aunt to three beautiful nieces and nephews!

2020

10 | Joanna Toner, OD ’21
Dr. Joanna Toner currently practices at the Washington Permanente Medical Group. She recently welcomed the adorable Anthony James into the world.

11 | Janice Trang, OD ’21
After completing her optometry degree, Dr. Trang completed a residency program in ocular disease, geriatric optometry and low vision rehabilitation at the Veterans Affairs Palo Alto Health Care System. She currently works at UCSF and VA Palo Alto as an optometrist. Since her undergraduate years, she has volunteered with AOJAH (Alliance of Jamaican American Humanitarians) to attend and organize annual medical mission trips to Jamaica. So far, she has attended the medical mission trip to Jamaica in 2016, 2017 and 2018. This year, she was able to attend as a provider! This trip enables vision care for over a thousand patients each year and provides them with glasses, cataract surgery, and glaucoma treatment to improve their quality of life. Other Berkeley alumni on the trip included Dr. Eric Viloria (OD ’20), Dr. Michael Wong (OD ’21), Dr. Sam Lee (residency ’22), Dr. Sheila Soltani (OD ’19), Dr. Tran Bianconi (OD ’17).

In Memoriam

1950

12 | Jimmy Low, OD ’52
Laraine Greenwood, OD ’88, shares the sad news that her dad, Jimmy Low, passed away on June 11 at the age of 98-1/2. He died of natural causes and continued to live independently at home as he wished. He had a wonderful life filled with family and friends and was happily married to his wife Lillian for almost 57 years before she passed in 2007. The couple traveled the world together—often proudly wearing their Blue & Gold. Both mom and dad were dedicated Cal Alumni, and dad was always appreciative of the education and training he received at Berkeley and ultimately the career and life that followed. He had a life well lived and will be missed.

1980

13 | Donald Matsumoto, OD ’80
Donald Michiaki Matsumoto, of Manhattan Beach California, died April 2, 2023, at Torrance Memorial Hospital due to complications from cancer. He was born on August 21, 1954, to Akira and Mary Matsumoto in Gardena, California. Don attended UCLA (BA in Economics) before coming to Berkeley, where he was was the recipient of the Golden Retinoscope Award. He was married to Cynthia Miyasaki, and had a daughter, Grayson. Don joined Pacific EyeCare in 1989 and became a partner in 1994. He was a fellow of the American Academy of Optometry, Diplomate of American Board of Optometry, Assistant Professor of Southern California College of Optometry (OCLA Clinic), and Medical Director of Vision Source. Don served on numerous committees, was chair of the Sponsorship Committee for the Los Angeles County Optometric Society, and had been an active member of the Asian American Optometric Society (AAOS). Dr. Matsumoto was known as the eternal Dodger fan. He collected bobble heads, baseballs, and even had two bleacher seats. In between exams, Don would listen to his transistor radio with the Dodger’s broadcaster Vin Scully calling out the plays. He said his life would not be complete until his team won the World Series again, which they did in 2020. Don will be greatly missed by his wife Cynthia, daughter Grayson, brothers Eddie and Mickey, and sister Susan, and his nieces, nephews and numerous cousins.

Gregory Alaniz, OD ’85
Greg was a devoted son, dedicated doctor and loyal friend. He practiced in San Diego, CA until his retirement. He departed this life too early. Greg will always be remembered for his intellect, quick wit and kindness. He will be missed.

Berkeley Herbert Wertheim School of Optometry & Vision Science

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