McPherson Eye Research Institute
UNIVERSITY OF WISCONSIN–MADISON

InSights

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Three New McPherson ERI Members Explore the Vision-Brain Connection

Dr. Rosa Lafer-Sousa , Dr. David Herzfeld, Dr. Vivian Paulun

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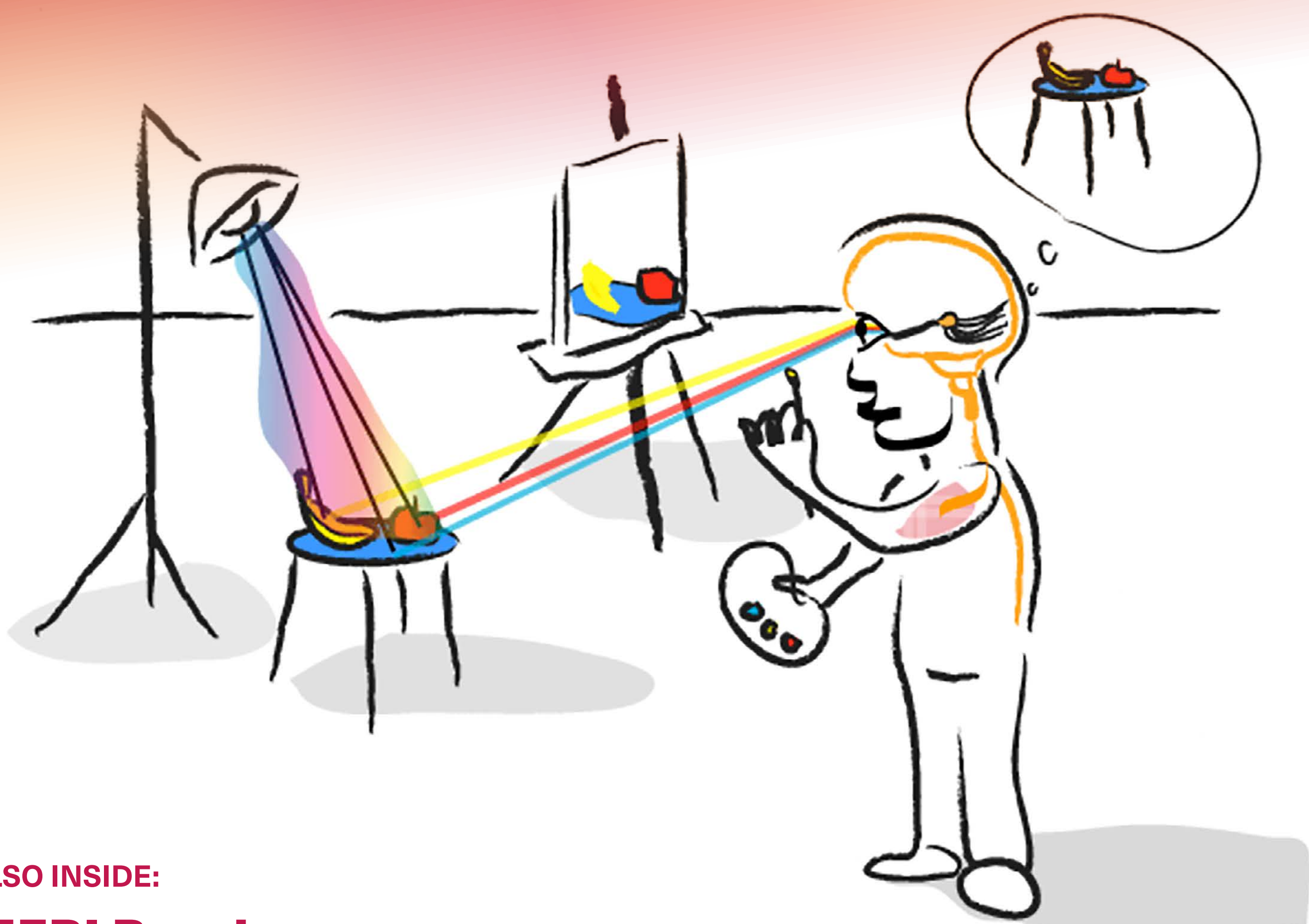


ALSO INSIDE:

MERI Reaches Out to the Wisconsin Community

From the Director

Dear Friends,

Every month, the McPherson ERI Leadership Committee begins its meeting with a discussion of applications from prospective new research members of the Institute. It's a gratifying conversation for many reasons, in part because it provides a periodic glimpse into the ever-evolving portfolio of scientific expertise and projects on campus and across the state. Many of our members are actively working on therapeutics for blinding diseases, while others are exploring entirely new concepts in vision science that have potential applications in both the near and long term.

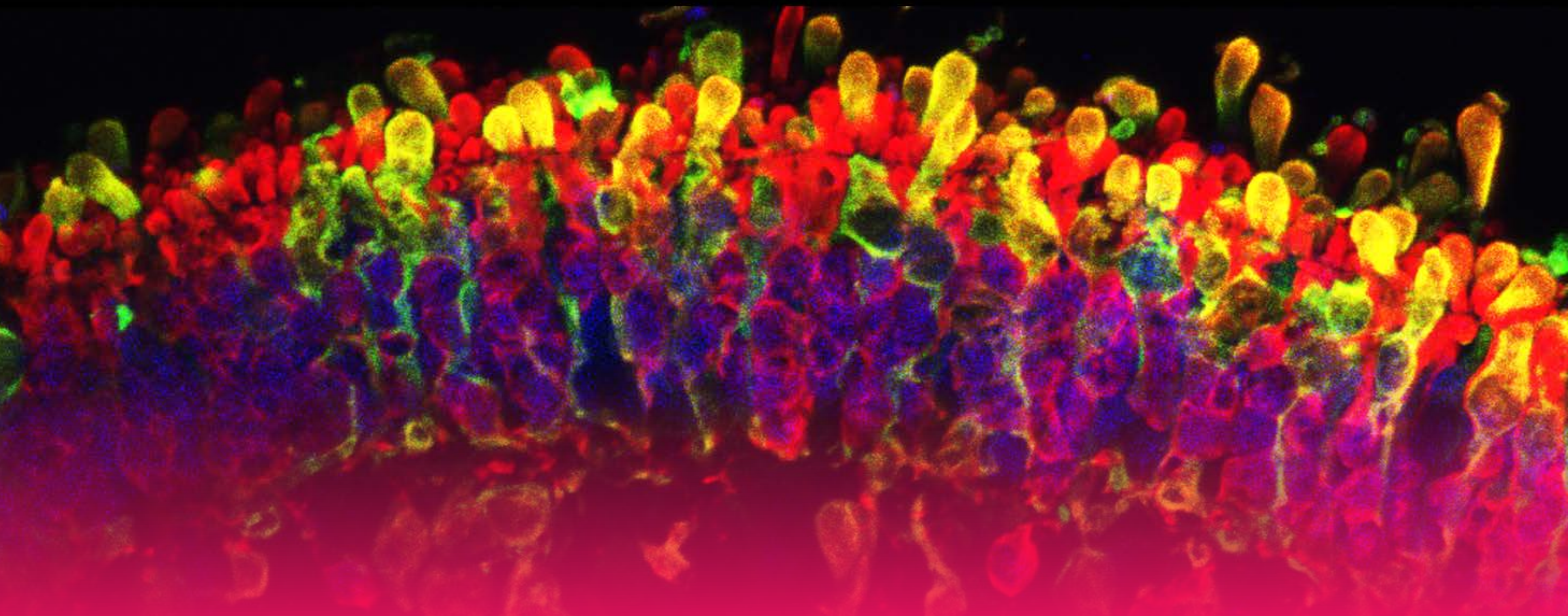
In this issue, the McPherson ERI welcomes three UW-Madison faculty members: Dr. Vivian Paulun and Dr. Rosa Lafer-Sousa in the Department of Psychology and Dr. David Herzfeld in the Department of Neuroscience. These recent 'recruits' are building labs that focus on different aspects of the most complex and least understood component of our visual system, the brain. Future research on color vision (Dr. Lafer-Sousa), neural coordination of eye and limb movements (Dr. Herzfeld), and visual 'intuition' (i.e., the ability to predict physical properties through observation) (Dr. Paulun), may ultimately lead to new or better therapies and technologies for people with low vision. In addition, these scientists add immeasurably to the rich expertise and dialogue that make the Institute—and UW Madison—greater than the sum of its parts.

In the following pages you will also find a feature detailing some of the Institute's community outreach activities, which connect us personally to those we aim to serve. Our co-founder, Dr. Alice McPherson, strongly believed that vision research should be widely shared—a concept that is shared more broadly by the 'Wisconsin Idea,' one of UW-Madison's core tenets. Given that Dr. McPherson received her undergraduate and medical degrees from UW-Madison and completed her ophthalmology residency training here as well, that's probably not a coincidence.

Thank you for your help and interest,

David M. Gamm, MD, PhD

- *Professor, Department of Ophthalmology and Visual Sciences*
- *RRF Emmett A. Humble Distinguished Director, McPherson ERI*
- *Sandra Lemke Trout Chair in Eye Research*



MERI Notes

Groundbreaking Stem Cell Clinical Trial Treats Its First Patient

This past July, BlueRock Therapeutics announced that, using a stem cell-derived therapeutic developed over more than a decade in Dr. David Gamm's lab at UW-Madison, the company had treated the first patient in a new Phase 1/2a clinical trial aimed at a group of inherited retinal disorders (including RP and cone-rod dystrophy). The initiative is the result of a strategic research alliance formed in 2021 between the Gamm laboratory, Opsis Therapeutics, Fujifilm Cellular Dynamics Inc., BlueRock Therapeutics, and Bayer to bring these therapies to patients. The induced pluripotent stem cell (iPSC)-derived photoreceptor cell product OpCT-001 is designed to restore functional photoreceptors to patients with RP and other retinal diseases leading to primary photoreceptor loss.

In response to news of this first treatment, Dr. Gamm noted that "...this is an important and necessary first step in testing this first-of-its-kind therapy, and we are grateful to all of the people participating and monitoring the trial. I am particularly pleased that this strategy and human iPS cell technology in general was born, developed, and refined here at UW-Madison."

Vision Research Update Recording is Now Available

In August 2025, the McPherson ERI hosted another Vision Research Update, live and on Zoom, including a discussion of current MERI initiatives in stem cell and gene editing therapies for inherited retinal diseases and AMD. A recording of the event is now available; if you're interested in receiving a link to the recording, please email or call Michael Chaim at **chaim@wisc.edu**, or **608-320-9347**.

Alice R. McPherson Archives Established at UW-Madison

UW Archives and Records Management and the **McPherson Eye Research Institute** have announced the establishment of the **Alice R. McPherson Archive and Oral History Project**. The McPherson Archive collects, preserves, and makes accessible to scholars a range of papers, photographs, and other materials related to the life and career of this medical trailblazer. The Oral History Project aspect of the McPherson Archive will consist of interviews with a wide range of Dr. McPherson's colleagues, including world-renowned researchers, Houston colleagues and friends, and UW-Madison colleagues. Materials will be catalogued and made publicly accessible in the next few years.

Dr. Alice McPherson completed her undergraduate and medical degrees at UW-Madison, as well as a residency in ophthalmology at the University Hospital. Following a term as the first female vitreoretinal fellow of Dr. Charles Schepens, considered to be "the father of modern retinal surgery," Dr. McPherson moved to Texas. As far as can be determined, she was the first full-time female retina specialist in the world. Her practice flourished thanks to her incredible commitment to her patients and determination to embrace new methods and advance the field of retina. She pioneered the application of many retinal treatments and won numerous awards for her work, notably becoming the first woman to receive the Gonin Medal.

Dr. McPherson was devoted to the advancement of knowledge and research in the field. In 1969, she founded the Retina Research Foundation (RRF) in Houston with donor gifts. The RRF continues to support numerous funding programs and awards for research on a variety of retinal diseases. Her relationship with UW-Madison continued to be close, and her pledged estate gift to UW—fulfilled following her death in 2023—was instrumental, along with her guidance, in ensuring the founding of the UW-Madison Eye Research Institute. In 2012, the Institute was renamed the McPherson Eye Research Institute (McPherson ERI) to recognize her immense contributions.

The McPherson ERI and UW Archives and Records Management are grateful to the Alice McPherson Estate for their initiation and encouragement of this project in honor of their friend and colleague, as well as the support of the Retina Research Foundation, Houston, for their participation and assistance with materials.

Turning Light into Meaning in the Brain

Every moment, the human visual system performs a remarkable feat. From the noisy patterns of light that strike the retina, the brain constructs a coherent, colorful world to guide behavior and thought. Understanding how this transformation happens—how the brain turns raw sensory data into perception—is the focus of vision scientist Rosa Lafer-Sousa, a new faculty member in the Department of Psychology and member of the McPherson Eye Research Institute.

Dr. Lafer-Sousa studies the neural and cognitive mechanisms that underlie perception—how specific brain circuits give rise to what we see, and how prior knowledge and expectations shape that experience. Her research focuses especially on color vision, a powerful model for understanding perception because color depends not only on the physical properties of light, but also on the brain's inferences about context.

One striking example comes from the viral image known as #TheDress (pictured here), which famously divided viewers into "blue and black" or "white and gold" camps. Dr. Lafer-Sousa conducted studies showing that these differences reflected how individual brains interpreted the lighting in the image: people who assumed the dress was in shadow saw it as white and gold, while those who assumed bright illumination saw blue and black. She used this real-world illusion as an opportunity to test long-standing hypotheses about how the brain resolves ambiguous color signals—an elegant demonstration of how science can transform a cultural phenomenon into a window on human perception.

To uncover how the visual system is functionally organized and how perception arises from brain activity, Dr. Lafer-Sousa works with human and nonhuman primates, combining psychophysics, brain imaging, electrophysiology, and optogenetics. (Optogenetics is a technique that allows her to activate or silence precise groups of neurons with pulses of light and observe how this alters perception and behavior). She has shown that stimulating certain areas of the primate brain can evoke vivid visual experiences—and that the nature of those effects depends on what the animal is looking at. This interplay between sensory input and internal brain state provides new clues about how perception is constructed.

In her upcoming work, Dr. Lafer-Sousa will use functional MRI-guided optogenetics to precisely target and manipulate functionally defined regions of visual cortex, such as those specialized for color, shape, or texture. By observing how these targeted stimulations alter perception and behavior, she will test how different parts of the visual brain causally contribute to our experience of seeing. Using several related techniques, she will create a whole-brain causal map of visual circuits—an approach that will lay the groundwork for future studies that trace how neural networks generate perception.

Another goal of the Lafer-Sousa lab is to employ innovative behavioral and machine-learning tools, developed with colleagues at NIH, to reconstruct what an animal "sees" during stimulation, creating rich visual "pictures" of perception in real time ("Perceptography").

By directly linking neural activity to changes in experience, Dr. Lafer-Sousa is bridging the causal gap between brain and perception. Her integrative approach—connecting behavior, brain, and technology—lays critical groundwork for the development of neural prosthetics that could one day restore sight in individuals with blindness by artificially recreating the brain's own visual patterns.

Disambiguating #theDress. Embedding the dress in a scene with overt cues about the lighting causes most people to perceive the dress in a predictable way: white and gold when a cool illuminant is simulated; blue and black when a warm illuminant is simulated. The pixels that make up the dress are identical in both panels. Cues to the illuminant are provided by a global color tint applied to the whole scene, including the skin of the model. Images created by Rosa Lafer-Sousa; background scene used with permission from Beau Lotto.

Seeing the Full Scene

Visual Intuitive Physics and Sight

Vivian Paulun is a new McPherson ERI member and a new addition to the faculty in UW-Madison's Department of Psychology, where she is an Assistant Professor. Her research program seeks to explain a fundamental human ability—visual intuitive physics, our capacity to understand the physics of a scene at a glance.

Everyday life constantly requires us to anticipate the physical world through vision. Before stepping onto an icy sidewalk, we judge whether it will be slippery. Before picking up a book, we gauge its weight from how much it has sunk into a couch pillow. Before we lift a glass of water, we predict how easily the water might spill over. These rapid inferences about the physical properties of objects and substances, the relationships between them, the forces acting on them, and what is likely to happen next are required for planning any conceivable action.

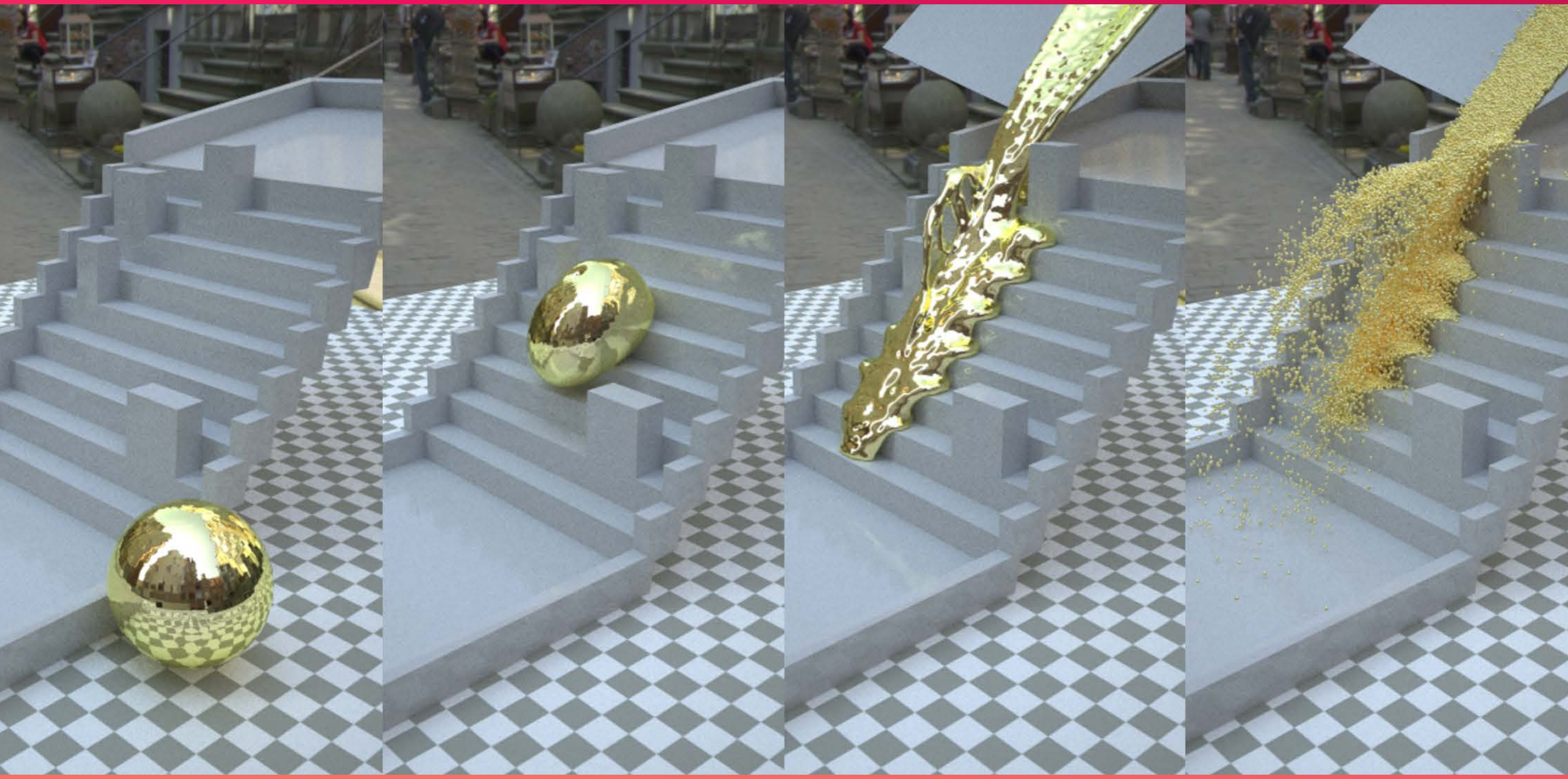
Yet, the underlying processes remain a major scientific puzzle. How does the brain transform the patterns of light entering our eyes into such rich physical understanding? And how do humans solve this task so effortlessly and with a robustness and flexibility that far exceeds even the most advanced artificial intelligence?

To tackle this challenge, Dr. Paulun's lab combines three complementary approaches. First, the lab runs behavioral experiments to measure how people perceive and reason about physical scenes. They leverage advanced computer simulations and renderings as tools to manipulate the visual scene. For example, how do people perceive an object that has a metallic appearance but starts to deform and wobble like a piece of jelly?

Second, the Paulun lab uses brain imaging to identify the neural systems that support these abilities. In a recent study, for instance, they found a functional division between brain regions that represent solid objects, like books or bananas, and those that represent non-solid substances, like honey or water.

Finally, they build computational models that simulate how humans might represent and reason about physics. Each method offers different insights, and together they allow the lab to connect cognition, computation, and brain function.

Dr. Paulun's long-term goal is to build a precise understanding of how humans achieve visual intuitive physics, and why our abilities are so robust compared to machines. By bridging psychology, neuroscience, and computational modeling, her work aims not only to explain a core feature of human intelligence but also to inspire the development of more flexible and human-like artificial intelligence.



Video stills from a recent neuroimaging study led by Dr. Paulun depicting examples of Things, i.e., rigid and deformable objects, and Stuff, i.e., liquid and granular non-solid substances. Paulun and colleagues found that parts of the visual cortex in the human brain are specialized in processing solid Things or flowing Stuff, like honey or sand. Image courtesy of Vivian Paulun, PhD.

Understanding How the Brain Learns...

One Eye Movement at a Time

When we think about vision, we often consider how our eyes capture light and how our brains process that information to help us see the world. But there's another critical part of seeing that many of us overlook—how our eyes move in the first place.

Incredibly, we move our eyes three to four times every second, constantly scanning our surroundings to take in new information and track moving objects. Some of these movements, called saccades, are lightning-fast jumps that happen in just a fraction of a second. These movements are so quick that we often aren't aware that they're even happening. Other movements, like smooth pursuit, help us follow moving objects, like a speeding car or a bird in the sky. All of the different types of eye movements depend on a carefully coordinated network of different brain areas that work seamlessly together.

Scientists have been studying these brain networks for decades, and while much is now known about which regions in the brain initiate and control eye movements, there are still many unanswered questions. For instance, exactly how many of these brain areas actually control eye movements remains a mystery.

With the support of the McPherson ERI, Dr. David Herzfeld, a new faculty member in the Department of Neuroscience, is working to solve these puzzles. One of his lab's focuses is to understand how the cerebellum, a brain region at the back of the head, controls eye movements. When the cerebellum is damaged by disease or injury, eye movements become clumsy and inaccurate. People may struggle to shift their gaze to the right place or have difficulty smoothly tracking moving objects.

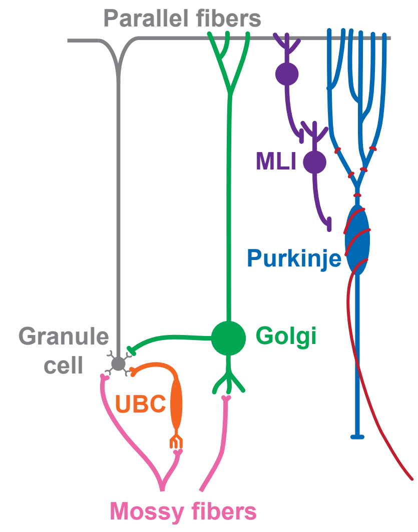
Recently, Dr. Herzfeld's research has identified the specific circuit-level processing that occurs in a key part of the cerebellum during smooth pursuit eye movements. Rather than looking at just individual neurons, his work reveals how entire neural circuits work together to control eye movements in real time. This new research helps scientists move beyond isolated pieces of the puzzle and toward a big-picture understanding of how the brain coordinates complex behaviors.

But Dr. Herzfeld's work doesn't stop at simply understanding how the brain controls eye movements. His research also explores how the brain learns and adapts. For example, throughout the day, your eye movements may slow down due to fatigue, but you typically don't notice because your brain adjusts your eye movements automatically. This type of fine-tuning of movement is another job of the cerebellum.

In his lab, Dr. Herzfeld uses carefully designed experiments to intentionally disrupt the accuracy of eye movements and observe how the cerebellum learns to compensate. By studying how entire neural circuits change as learning occurs, his team is beginning to uncover the fundamental rules of motor learning. These insights could one day help speed up recovery after strokes or injuries by teaching the brain to re-learn movements more quickly.

The Herzfeld Lab's research is supported by the National Institutes of Health, including the National Eye Institute, the McPherson Eye Research Institute, and the UW-Madison Office of the Vice Chancellor for Research. With this support, the Herzfeld Lab helps us better understand not only how we move our eyes, but also how the brain learns, adapts, and changes.

The cerebellum, a part of the brain involved in movement and learning, is made up of different kinds of neuron cells arranged in a precise pattern. Mossy fibers (pink) bring in information about eye movements from the rest of the brain to the cerebellum. The cerebellum processes this information, and the results are sent back to the rest of the brain by Purkinje cells (blue). Dr. Herzfeld's research explores how these brain circuits calculate and adapt during eye movements and learning. Image courtesy of David Herzfeld.



Inspiring the Next Generation

MERI's Vision Science Outreach Program Reaches across Wisconsin

The McPherson Eye Research Institute is doing more than advancing scientific discovery. We're actively shaping the future of science education in Wisconsin through our fast-growing outreach program. From classrooms in the Madison Metropolitan School District (MMSD) to science festivals throughout Dane County and beyond, MERI is making vision science come alive for thousands of students each year.

At the heart of the outreach program is a commitment to hands-on, inquiry-based science education. MERI's engaging lessons—which include activities like dissecting bovine eyes, simulating visual disorders, exploring night vs. day vision, and (soon) using virtual reality (VR) to tour the brain—bring abstract concepts into focus for students of all ages. While the program initially focused on elementary and middle school students, it has recently expanded to meet increasing demand from high schools, and from teachers in rural districts outside of Dane County.

In the Spring 2025 semester alone, MERI volunteers taught vision science in 62 classrooms, reaching nearly 1,500 students directly. Several thousand more participated in programs at local science expos and festivals, including the East High School Science Expo, UW Science Expeditions, and STEAM family science night.

This expansion is fueled by MERI's mission to inspire curiosity, train future scientists, and embody the Wisconsin Idea, the belief that education should benefit people beyond the boundaries of the university. MERI trainees, most of whom are graduate students and postdocs at UW-Madison, find outreach deeply rewarding. It gives them the opportunity to develop their teaching skills while making science exciting and accessible to young learners.

At the same time, the overwhelming demand from teachers and enthusiasm from students makes the program's impact clear. Participating teachers have expressed appreciation for MERI's presence in their classrooms. Kristen Riddle, a science leader with MMSD, praised the program's ability to captivate and educate: "Students were very engaged and were asking great questions. Teachers and students have really appreciated the work [MERI] has done."

To keep up with demand, the Institute has doubled its volunteer training sessions and is piloting a hybrid training program to help teachers lead these lessons themselves. This not only expands the reach of the program but also empowers educators across Wisconsin to deliver hands-on science in their own classrooms using MERI's model and kits.

Looking ahead, MERI plans to continue innovating, with new lesson plans in development and the goal of expanding statewide. Our members believe that a spark of curiosity can ignite a lifelong interest in science, and that learning about vision can help students understand the importance of sight. We're bringing this lesson to students, one classroom at a time.

MERI Outreach: Anna Shen at East High, Freya Joessel & Ezgi Yuksel at UW SMPH, and Luce Meeuwsen at the Wisconsin Veteran's Museum.

Visit the McPherson ERI Mandlebaum & Albert Family Vision Gallery this Fall.

Save the Date!

Cycle for Sight 2026
Princeton Club West Kickoff
Saturday, March 14, 2026

At year's end, please support research on vision loss at the McPherson Eye Research Institute.

For more information Visit **vision.wisc.edu/giving,** or contact Michael Chaim at **608-320-9347** or **chaim@wisc.edu.**

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