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MORTIMER B. ZUCKERMAN MIND BRAIN BEHAVIOR INSTITUTE

Columbia's Carol Mason Elected to National Academy of Sciences for Pioneering Research into Brain Science of Sight

~ Academy recognizes decades of work to map complex pathways that connect the eye to the brain; research that could inform treatments of developmental and vision disorders ~

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NEW YORK — At the turn of the 20th century, the world got its first glimpse at the inner workings of the brain. Using a simple microscope, pen and paper, anatomist Santiago Ramón y Cajal produced drawings and never-before-seen details of the nerve cells that comprise the brain and spinal cord. This accomplishment laid the groundwork for modern neuroscience.

Today, the tools of Cajal's time have been largely replaced by their digital equivalents. But researchers have proven that some questions in brain science still benefit from peering into a microscope and putting pen to paper. One such researcher is neuroscientist Carol Mason, PhD, a principal investigator at Columbia's Mortimer B. Zuckerman Mind Brain Behavior Institute, who is widely regarded for her groundbreaking research into how the visual system develops and is organized.

In recognition of her life's work, she was recently elected to the National Academy of Sciences, the nation's most prestigious body of scientific scholars.

"Dr. Mason is a spectacular neuroscientist, whose pioneering studies have illuminated our understanding of brain development," said Steven Siegelbaum, PhD, a principal investigator at Columbia's Zuckerman Institute, in a statement. "But at the same time, Dr. Mason is also a wonderfully generous colleague and citizen, who has worked tirelessly to support neuroscience, both at Columbia and at the national level."

Dr. Mason has dedicated her career to solving a fundamental and critical question in neuroscience: How do nerve cells from the eye extend back into the brain in just the right way to endow us with sight? To answer this question, she has at times relied on methods inspired by Cajal.

"My research was originally driven by my drawings; from literally tracing the form that these immature, growing cells take as they stretch from the eye and extend deep into the brain," said Dr. Mason, who is also a professor of pathology and cell biology, neuroscience and ophthalmic science (in ophthalmology) at Columbia University Irving Medical Center.

Much of Dr. Mason's career has focused on a type of nerve cell called the retinal ganglion cell, a neuron that connects the eye's retina to the thalamus, deep inside the brain. Extending from each of these cells is a thick root called an axon. To learn how these axons weave their way toward the thalamus, she channeled Cajal.

"We stained the ganglion cells with a dye so they would be individually visible in the microscope," she said. "Then, using a camera lucida — which projects the cells' shapes onto paper — we traced the cells' axons by hand during different stages of growth. We then turned these still scenes into live action by making movies of the living cells we had viewed under the microscope."

Dr. Mason observed that these axons exhibited an unusual growth pattern. By focusing on the growth cones at the tips of the axons, she found that most ganglion cells extend their axons along the same side of the brain from where they started. The remaining axons take a sharp turn toward to the opposite side of the brain, seeming to hit an invisible wall near the middle of the bottom of the brain.

Further research revealed how the cells' axons accomplished this: a different set of molecular tags dot the surface of each population, and each type of tag interacts differently with the environment where the axons diverge. If an axon bears one set of tags, it stays on the same side; a different set of tags allows passage to the brain's opposite side.

"This splitting of the circuit — in which each side of the brain receives signals from both eyes — endows the brain with depth perception and allows us to see in 3D," said Dr. Mason.

Building on this discovery, she is now characterizing where and when these retinal ganglion cells are born, and how they inherit the genes that establish the differences in these two sets of molecular tags.

Her research stands to advance scientific understanding of genetic disorders where the visual system's cellular circuitry is organized abnormally. One prime example is albinism, defined by a lack of pigment in the hair, skin and eyes.

"In albinism, the absence of pigment is correlated with an imbalance in the percentage of retinal ganglion cell axons that cross over to the opposite side of the brain, meaning that the visual field is skewed, and stereovision is impaired," said Dr. Mason. Deducing the causes of this imbalance could inform the development of new therapies.

For Dr. Mason, being elected to the National Academy represents the next phase of her life's journey to unravel the mysteries of the brain.

"The National Academy of Sciences celebrates a lifetime's journey of one's research," she said. "As scientists, we are often so focused on publishing a paper or funding a grant. Joining the National Academy gives me a moment to reflect on my own journey — where I've been in the field of neuroscience and where I'd like to go next."

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Dr. Mason, who joined Columbia in 1987, is also a member of the National Academy of Medicine (elected in 2011) and the American Association for the Advancement of Science (elected in 2006) and is a Simons Foundation Senior Fellow. From 2013-2014, she served as president of the Society for Neuroscience. In 2017, she was awarded the Champalimaud Vision Award (2016) from the António Champalimaud Foundation. At Columbia, she has co-directed the Doctoral Program in Neurobiology and Behavior and the NIH-supported Vision Sciences Training Program. In her role as Chair of Interschool Planning in the Zuckerman Institute, she is fostering faculty recruitment and scientific collaboration across Columbia's campuses.

The National Academy of Sciences is a society of distinguished scholars established by the U.S. Congress in 1863. They provide independent, objective advice to the nation on matters related to science and technology. Members are elected by their peers in recognition of outstanding research achievements. Membership is considered one of the highest honors in science. There are approximately 2,300 members and nearly 470 foreign associates in the National Academy of Sciences.

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