FOR IMMEDIATE RELEASE:
Thursday, February 25, 2016

USC Eye Institute researchers use Human Connectome Project brain mapping techniques to unlock mysteries that can lead to vision-restoring therapies

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LOS ANGELES – The University of Southern California (USC) Eye Institute researchers are part of a multidisciplinary, collaborative USC team that recently received a $4 million grant from the National Eye Institute (NEI) to investigate how the human brain is affected by blinding eye diseases. The cross-school USC research team includes clinician-scientists in ophthalmology, psychology, neurology and neuroimaging working together in an effort to accelerate future treatments and therapies to restore sight.

The team will use the world's most advanced retinal imaging combined with the comprehensive brain mapping techniques developed in the ambitious Human Connectome Project – originally funded through $40 million in grants by the National Institute of Health (NIH) in 2010 – to unlock the mysteries of the brain as it relates to vision loss.

The four-year brain mapping research initiative, "Human Connectomes in Low Vision, Blindness and Sight Restoration," is led by principal investigator Bosco S. Tjan, PhD, director of the Laboratory for Functional and Computation Vision and co-director of the USC Dornsife Cognitive Neuroimaging Center, who is joined by USC Eye Institute clinician-scientists including co-investigators: James Weiland, PhD; Amir H. Kashani, MD, PhD; Andrew Moshfeghi, MD, MBA; Lisa Olmos de Koo, MD, MBA and Vivek Patel, MD. Other USC colleagues involved in the project include Meng Law, MBBS, and Yonggang Shi, PhD.

"The brain mapping research will provide a baseline that in turn allows a more comprehensive understanding of conditions that affect the retina and the downstream consequences in the central visual pathways and with this knowledge, we can better treat visual impairments," said Dr. Weiland, who is both a USC professor of ophthalmology as well as of biomedical engineering. "We'll achieve this through creation of an enormous database of information that ultimately provides a better roadmap to optimize current vision restoration treatments such as Argus II implants for retinitis pigmentosa patients, stem cells to help with age-related macular degeneration or surgical precision to treat tumors on the optic nerve."

"This is the first large-scale, HCP-related study on vision loss, and it is a great example of close collaboration between USC Eye Institute, the USC Dornsife College of Letters, Arts and Sciences, and the USC Viterbi School of Engineering," said Dr. Tjan, a psychology professor for USC Dornsife. "In a visually impaired individual, our unique techniques allow us to link every point on a diseased retina to the corresponding

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locations in the brain that receive or transmit the visual input that originated from that retinal location. This fine level of eye-brain correspondence allows us to make highly specific measurements on how vision loss affects the brain, and how changes in the brain may impact the outcome on treatments aimed to restore vision."

The investigations will explore the pre-conditions of brain structure and function as related to the central vision pathway (CVP) thereby better understanding the broader consequences of eye disease. This advanced retinal pathology knowledge and greater insights on the CVP's impact can improve and optimize current therapies for vision restoration and help decode new treatments yet undiscovered.

The premise of researchers is that patients differ in how they respond to vision restoration therapies based not just on the specific eye disease diagnosis but also in how each patient's brain is wired. While the study will yield big data insights that can have broad impact for many patients, equally important is the focus of the researchers on the personalized medicine aspect of enhancing each patient's treatment options through the data collected in the individual bran scans.

Some of the unique aspects of the brain mapping vision research project at the USC Eye Institute include the infrastructure. USC is one of the few institutions in the country to have the Siemens 3T Prism scanner, which is the preferred MRI scanner for the Human Connectome project.

"The brain mapping research gives us the key to both personalized medicine to more effectively treat individual patients as well as giving us the big data knowledge we need to innovate future therapies and treatments that can impact a broad spectrum of patients," said Rohit Varma, MD, MPH, director of the USC Eye Institute. "We are fortunate to have our clinical and scientific research teams housed at USC where we can collaborate on initiatives such as these and where we can tap into the work being done by other USC centers and laboratories whether it's neuroimaging or biomedical engineering."

Dr. Varma is referring to Arthur Toga, PhD, and Paul Thompson, PhD, of the USC Mark and Mary Stevens Neuroimaging and Informatics Institute, which houses the world's largest collection of brain scans. Drs. Toga and Thompson are pioneers in brain mapping and have been part of the NIH Human Connectome Project from the beginning. In addition, collaborations between the USC Eye Institute and the USC Viterbi School of Engineering have yielded innovations such as the Argus II which co-created by Mark Humayun, MD, PhD, co-director of the USC Eye Institute.

The USC Eye Institute is ranked in the Top 3 of the nation's top grant recipients from the NEI and has achieved more than $32 million in annual grant funding.

About the USC Eye Institute

The USC Eye Institute, part of the Keck Medicine of USC university-based medical enterprise, has been a leader in scientific research and innovative clinical treatments for 40 years. Among the top three funded academic-based medical centers by the National Eye Institute (NEI) research grants and ranked in the Top 10 ophthalmology programs in *U.S. News & World Report*'s annual "Best Hospitals" issue for more than 20 years, the USC Eye Institute is headquartered in Los Angeles with clinics in Arcadia, Beverly Hills and Pasadena.

Patients from across the country come to see the USC Eye Institute experts who treat a comprehensive array of eye diseases across the life spectrum from infants to aging seniors. The USC Eye Institute is known for its scientific research and clinical innovation including: creation of the Argus implant (also known as the "bionic eye") for retinitis pigmentosa patients; stem cell therapies for those who have age-related macular degeneration; discovery of the gene that is the cause of the most common eye cancer in children; treatment for eye infections for AIDS patients; inventors of the most widely used glaucoma implant in the world; pioneers of a device for long-term intraocular drug delivery; and the first to use telesurgery to train eye doctors in developing countries. For more information visit: eye.keckmedicine.org. or usceye.org.

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