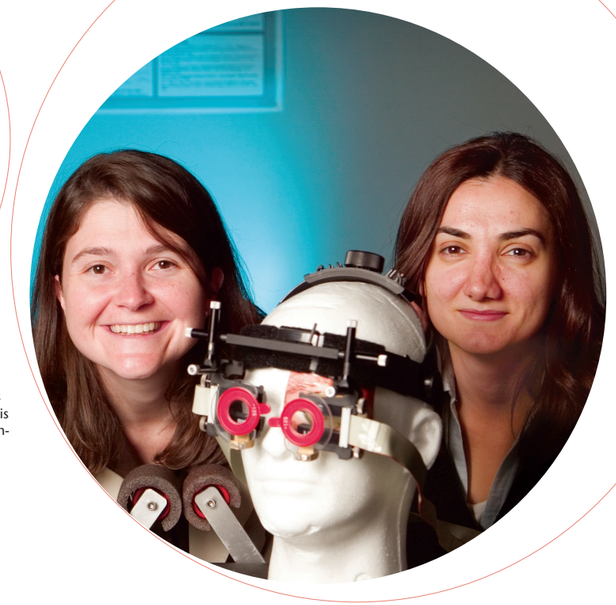

Associate Professor Tara Alvarez (center) with graduate students Sang Jin Han and Yelda Alkan. The wearable equipment shown is used to gather eye-movement data for research into the relationship between vision and other neural and muscular functions. Sita Kulkarni '07 (below) also participated in vision research as a student.

New Insights Into Vision

"OUR EYES ARE THE GREAT MONOPOLISTS OF OUR SENSES" — DIANE ACKERMAN

SOME 80 PERCENT OF ALL THE INFORMATION WE ACQUIRE ABOUT THE WORLD AROUND US IS VISUAL, SAYS ASSOCIATE PROFESSOR OF BIOMEDICAL ENGINEERING TARA ALVAREZ, ADDING AN EMPIRICAL NOTE TO THE LYRICAL ASSESSMENT OF HUMAN VISION OFFERED BY THE POET DIANE ACKERMAN. ALVAREZ IS ALSO DIRECTOR OF NJIT'S VISION AND NEURAL ENGINEERING LABORATORY, WHERE SHE AND HER COLLEGUES ARE ENGAGED IN RESEARCH THAT CAN INCREASE OUR BASIC UNDERSTANDING OF VISION AND LEAD TO BETTER THERAPIES FOR ILLNESS AND INJURY.

The sensory preeminence of vision underlies a strong connection between the physiology of sight and other neural and muscular functions — functions that can be impaired by afflictions such as traumatic brain injury, or TBI. Now a major focus of her research, Alvarez says that TBI is emerging as a serious national health issue, with automotive accidents being one major cause. In New Jersey, a portion of fines collected for traffic violations helps to further the work of the state's Commission on Traumatic Brain Injury as well as that of the Commission on Spinal Cord Research.

Current military action in Afghanistan and Iraq has been even more instrumental in calling the nation's attention to TBI. That's because a substantial percentage of the wounds sustained by U.S. personnel involves TBI. This is due to the ordnance used by adversaries in both areas, particularly weapons that include the improvised explosive devices often referred to as IED's.

Looking at TBI

Alvarez says that mild TBI is especially difficult to diagnose with conventional MRI scans because the neural damage tends to be more diffuse and subtle compared to the localized effects typically associated with illnesses such as a stroke. But as her previous work has demonstrated, a great deal about neural impairment affecting memory, attention and visual functions can be inferred from eye movement.

Accordingly, Alvarez has teamed with colleagues at NJIT, the University of Medicine and Dentistry of New Jersey (UMDNJ) and the State University of New York (SUNY) to develop special techniques and equipment for studying TBI. Those joining Alvarez in this effort include Kenneth Ciuffreda and Bharat Biswal. Ciuffreda, doctor of optometry and PhD in physiological optics, is a distinguished professor at the SUNY College of Optometry. Biswal, whose PhD is in biophysics, is an associate professor in the UMDNJ Department of Radiology.

A primary goal is to gain new knowledge about TBI by integrating the use of equipment that monitors eye movement with functional magnetic resonance imaging (fMRI), a relatively new and more capable neuroimaging tool. Individuals tested will visually track targets displayed on the interior of the fMRI enclosure while performing exercises only with their eyes to accommodate the need to keep one's head immobile for the fMRI scans. Ocular movement utilizing motor learning and memory exercises will be correlated with fMRI data about blood flow in the brain. In addition to increasing basic physiological knowledge, Alvarez and her colleagues hope that their functional-imaging research will lead to better therapies for TBI.

Filling an empty room

As an undergraduate, Alvarez's path to the scientific frontier of perception began with a BS in electrical engineering from Rutgers. She was inspired to become an engineer by her father, a mechanical engineer. "While electrical engineering was very interesting," she says, "I came to feel that the biomedical field would be more personally fulfilling." This inclination motivated her to take MS and PhD degrees in biomedical engineering, also at Rutgers.

Upon completing her doctorate, Alvarez was employed at a start-up specializing in immunoassay technology and then at Bell Laboratories, where she focused on advanced signal-processing for telecommunications networks. Research into leading-edge data transport was actually a good fit with her electrical-engineering expertise and knowledge of the analogs to be found in neural physiology. However, 2001 brought a different and very attractive opportunity — an invitation to join NJIT's newly formed Department of Biomedical Engineering and to build the program for the vision and neural engineering lab from the ground up.

"I was shown an empty room and told that was my lab," she says. Alvarez has since filled the space with equipment and accomplishments. The equipment includes unique wearable systems that gather ocular data for analysis. The accomplishments have included deeper understanding of motor learning that could be applied to helping people who have had a stroke — specifically, those for whom a stroke has caused visual field neglect. The effects of this condition can include seeing only one-half of a nearby clock — the numbers one through six — with the other half seemingly not there.

Convergence insufficiency is another condition she is studying. A common manifestation of this difficulty is an inability to read for more than 15 or 20 minutes without experiencing blurred vision and fatigue, debilitating impairments in the workplace and in many other situations.

In each instance, investigation of the basic science has been complemented by applying the insights gained to developing therapeutic exercises. Such exercises can be beneficial because of our neural plasticity. In Alvarez's words, that's our capacity to "rearrange the brain's real estate" to achieve functional improvement.

Publication in prestigious journals such as *Vision Research,* the *Journal of Vision* and *Ophthalmology* is one indication of the significance of Alvarez's work. She has also received a $400,000 National Science Foundation CAREER Award in support of her efforts. This NSF program recognizes educators and researchers with special potential for leadership in their disciplines.

Sparking excitement

However demanding of her time, research is not the only priority for Alvarez. Her commitments as an educator include participation in the university's pre-college programs for elementary and high school students, especially activities seeking to foster an interest in science and technology among young women. She has designed courses in her department, and actively involves undergraduate and graduate students in her investigations as part of their learning experience at NJIT.

"I love to see students learn, to see new knowledge spark excitement," Alvarez says. That excitement is clearly shared by Alvarez as well as by her students. ■

AUTHOR: Dean L. Maskevich is editor of *NJIT Magazine.*

For more about biomedical engineering at NJIT: http://biomedical.njit.edu

PHOTOS: (ABOVE) KAI CHAN, (BOTTOM) DOUG PLUMMER