The program, begun in 1995, has supported some 784 fellows, two-thirds of them at the doctoral level. The fellowships are just one component of a $100-million-a-year STAR research effort, which will continue.

"It gave me the freedom to pick a research topic, as well as buy a computer and travel to conferences," says CMU environmental policy graduate student Felicia Wu, who expects to have completed her Ph.D. by the time her STAR fellowship ends in August. Wu, who hopes to work in the public policy arena, says that the 3-year fellowship allowed her to switch to a project on genetically modified corn after funding for a study of drinking-water quality ran out.

The STAR program is one of two EPA education programs targeted in the 2003 budget request, the other being $9 million for environmental activities with elementary and secondary school students (*Science*, 8 February, p. 954). The $19 million being spent on them would be shifted to the National Science Foundation.

—JEFFREY MERVIS

NEUROSCIENCE

Neurons Turn a Blind Eye to Eye Movements

If our mind were to see what our retinas see, the world would seem herky-jerky. That's because our eyes continually dart from place to place, causing an image to jump about on our retinas. The brain smooths the scene by briefly blanking out visual perception when the eyes jump. A simple demonstration illustrates this: Look at one of your eyes in a mirror. Then look at your other eye. Then back to the first. You will not see your eyes move, even though a person watching over your shoulder would easily see the rapid eye movements known as saccades.

Neuroscientists have long debated the origin of this momentary blindness, known as saccadic suppression. Some argue that the brain does it solely based on information coming from the retina, while others think it uses additional, nonretinal signals coming from brain areas such as those that move the eyes. Now researchers have the first hard evidence for such an "extraretinal" mechanism. On page 2460, Klaus-Peter Hoffmann, Alexander Thiele, and their colleagues at Ruhr University in Bochum, Germany, report that they have identified visual neurons that distinguish between real movements of a scene and the shifts caused by saccades.

"This is the golden fleece that people have been looking for," says University of California (UC), Santa Cruz, neuroscientist Bruce Bridgeman, "neurons that respond differentially to a saccade." The results, he says, prove that extraretinal signals alert the neurons when a saccade occurs.

Neuroscientists discovered decades ago that experimental subjects—whether people or monkeys—don't usually perceive images during a saccade. Work from many labs traced this inability to a so-called masking effect: Whereas the visual system receives crisp, clear signals before and after an eye movement, explains neuroscientist Robert Wurtz of the National Eye Institute (NEI) in Bethesda, Maryland, "what is received during the eye movement is blurred and of lower contrast." The blurred signal is swamped out by the stronger before and after views that come from the retina.

In 1968, Wurtz made recordings from monkeys' visual neurons that supported the masking model and cast doubt upon the role for extraretinal signals in saccadic suppression. He recorded from neurons in monkeys' primary visual cortex, one of the brain's first relay stations for visual information, under two conditions: while the animals were making saccades, or while they were holding their eyes still and the visual scene jerked in a way that mimicked a saccade. If the neurons received extraretinal cues during a saccade, they might respond differently in the two cases. But the neurons responded identically, suggesting that the only information they received came from the retina.

Since that time, researchers have characterized visual areas beyond the primary visual cortex. Hoffmann's team tested whether extraretinal signals of saccades may be reaching two of these higher visual areas, the middle temporal (MT) and middle superior temporal (MST) areas. They specialize in detecting motion and so have a strong need to suppress saccade-generated image motion.

Hoffmann's team recorded from MT and MST neurons in monkeys trained to focus on one spot in a scene projected onto a screen, then to shift their gaze to another spot. At other times the monkeys knew to keep their eyes steady while the scene shifted in a way that replicated its movement across the retina during the saccade. Some neurons responded identically in both cases. But others distinguished between the conditions, firing when the scene moved but not during a saccade. This was the smoking gun: Because the retinal signals were the same in both cases and the only difference was the eye movement, this suggested the neurons receive an extraretinal message that the eyes moved.

Other neurons responded in an even more remarkable way. Neurons in MT and MST normally register movement in a favored direction. But during saccades, some fired in response to motion in the opposite direction, effectively producing a false report of the direction in which the image moved. For example, during a saccade, a neuron that normally reacted to things moving to the right would instead respond to leftward motion. Hoffmann and his colleagues suggest that these "switching" neurons may cancel out signals from the neurons that respond normally to image movement induced by a saccade.

The experiment "pretty well nails" the idea that extraretinal signals help the brain suppress vision during saccades, says UC's Bridgeman. NEI's Wurtz agrees but notes that it does not negate the role of masking.

Invisible to you. Neurons in the MT and MST may suppress image movements encountered when the eyes jump.

CREDIT: A. STONEBRAKER

Neuroscientist Richard Andersen of the California Institute of Technology in Pasadena suggests that MT and MST may have a special need to rely on extraretinal signals. These motion-sensitive areas show little activity when the scene is still, but when the eyes shift they are deluged with motion signals. The areas "need some way of canceling them," Andersen says, but may lack before and after activity strong enough for masking.

Some researchers question elements of the story, however. John Findlay, who studies eye movements at the University of Durham, United Kingdom, finds it "a little difficult" to accept that the neurons' signals would be similar enough in strength to cancel each other out. Others note that it is difficult to reproduce the way an image moves on the retina during a saccade; they worry that image discrepancies may account for some of the data. But none doubt the Hoffmann team's evidence that an extraretinal signal tells MT and MST neurons of a saccade. The next challenge will be to determine which brain area is sending that signal. Then yet another veil will be lifted from before vision researchers' eyes.

—MARCIA BARINAGA