grams. Small's plan would also create discipline-based institutes in astrophysics, geology and earth sciences, and the life sciences. A fourth, perhaps in conservation biology, would encompass the Smithsonian's remote field sites in Panama, Florida, and Maryland. Currently, each administrative unit, be it the CRC or a museum department, operates its own research program.

With personnel details yet to be announced, the proposed closures have had a devastating effect on staff members. "Morale is just right down in the basement," says one biologist who requested anonymity. Beyond the impact on their job status, some museum researchers worry that creating disciplinary institutes could conflict with the Smithsonian's stated mission of increasing the diffusion of scientific knowledge by putting too much distance between its scientific and educational activities. –ELIZABETH PENNISI

NEUROSCIENCE

Location Neurons Do Advanced Math

A mouse's minutes are numbered if it rustles through a field within hearing distance of a barn owl. The owl knows where to aim its talons even in the dark, thanks in part to a precise map of auditory space engraved in its brain's inferior colliculus, located in the brainstem. Now researchers have discovered that space-specific neurons in this map can perform more sophisticated computations than are commonly credited to neurons: Most neurons simply add incoming signals to come up with an answer, but neurons in the owl's auditory map multiply.

Where did it go? Some barn owl neurons multiply location signals.

If a mouse squeaks to an owl's right-wing side, the owl's right ear registers a slightly louder signal, and slightly sooner, than the left ear. Earlier research by Masakazu Konishi and colleagues showed that a set of auditory neurons calculates this interaural level difference (ILD) and interaural time difference (ITD) and sends the results to neurons in the inferior colliculus that are precisely tuned to particular locations. Humans use ILD and ITD cues as well, but the human auditory map isn't as well understood as the barn owl's.

To discover how the owl's space-specific neurons process the incoming timing and level information, neuroscientists José Luis Peña and Konishi of the California Institute of Technology (Caltech) in Pasadena outfitted 14 barn owls with headphones and monitored the auditory map's responses to pairs of sounds. As they report on page 249, multiplication best describes how the neurons behave; a multiplicative model predicts how the neurons respond to different kinds of stimuli with about 98% accuracy.

"This is the cleanest evidence of multiplication in the brain," says Christof Koch, also of Caltech but not involved in the project. He points out that many neural tricks in humans as well as owls seem to require multiplication, such as keeping neurons in the visual cortex trained on one spot even when the eyes or head move. But most earlier reports of multiplicative neurons relied on "dirty multiplication," he says—some combination of addition and multiplication that wasn't as satisfying as that in this new report.

Two properties illustrate what it means for a neuron to multiply. First, when very faint ITD and ILD signals correspond to the same region of space (giving mutually affirming indications that a mouse is underneath a log off to the right, say), neurons in the inferior colliculus fire robustly. If the two subthreshold signals were added, in contrast, their combined stimulation wouldn't rile up the space-specific neurons enough to fire. Second, the lack of either an ITD or an ILD signal can veto a space-specific neuron's firing. In multiplication, $2 \times 0 = 0$; in a barn owl's inferior colliculus, a strong ITD signal × no ILD signal = no response. As Peña explains, the neuron acts like an "and" gate, requiring both signals, rather than an "or" gate, which could respond to just one.

Archetypal neurons don't compute this way. Normally, a neuron receives a host of excitatory and inhibitory signals of various volumes along its dendrites. When the signals add up to surpass some threshold, the neuron fires. Such a neuron acts like a transistor in an electronic circuit, says Koch. But a neuron with the power to multiply, he says, "is more like a little processor; computationally it's much more powerful."

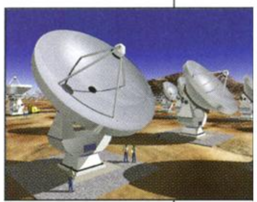
Mathematically, the behavior of these space-specific neurons is easy to explain. Neurophysiologically, it's another matter. "We don't know anything about how [multiplication] is computed" in these neurons, says Koch. Peña says his and Konishi's "next step is to figure out the biophysical mechanisms that underlie" the multiplication. –LAURA HELMUTH

CREDITS: (TOP TO BOTTOM) ESO; J. L. PEÑA ET AL.

ScienceScope

ALMA Matters Astronomers' hopes of building a giant 64-dish radio telescope have taken a big international step forward. Japan last week joined North America and Europe in the consortium planning the $550 million Atacama Large Millimeter/Submillimeter Array (ALMA), planned for Chile's Atacama desert.

In the mid-1980s, astronomers in North America, Europe, and Japan independently started planning such arrays, which will probe the formation of stars and galaxies. North America and Europe officially combined their efforts in 1997. Last week's resolution means scientists from 15 countries on four continents are now working on ALMA, making it "truly a world telescope," says Norio Kaifu of Japan's National Astronomical Observatory.



The next challenge is building it. The Bush Administration has not included any construction funds in its 2002 budget request (see p. 182), although Japan's education ministry has given ALMA a green light, and Europe hopes to keep pace. If the money begins flowing by the end of 2002, scientists say ALMA could be operating by 2010.

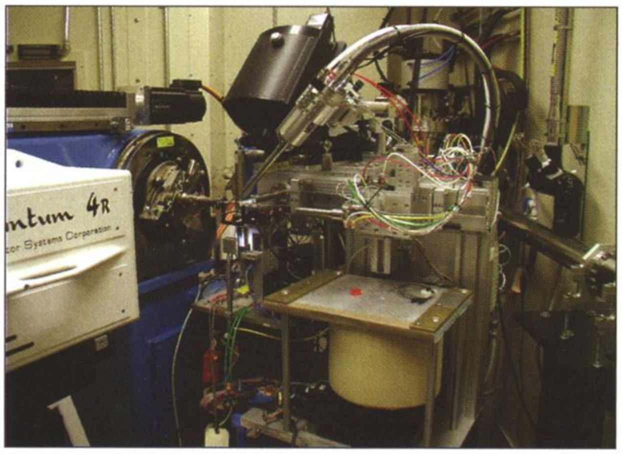
Depressing Difference Eighth-grade students from Naperville, Illinois, a wealthy suburban district nestled between Fermilab and Argonne National Lab, learned last week that they lead their peers around the world in understanding science. Their urban counterparts 30 minutes away in Chicago city schools, however, rank with the likes of Iran and Tunisia near the bottom of the list. The results were part of an exercise in which 13 state and 14 local U.S. school districts compared themselves to 38 countries that took the Third International Mathematics and Science Study in 1999.

National educators hailed the "courage" of big-city school superintendents like Chicago's Paul Vallas to spend $75,000 on what was a predictable academic drubbing, given the socioeconomic advantages of districts like Naperville. "These results make the gap visible and therefore attackable," thundered Education Secretary Rodney Paige. Sitting next to National Science Foundation director Rita Colwell, whose agency has spent hundreds of millions of dollars in the past decade trying to improve science and math in big-city schools, Paige declared that the reforms have produced "islands of excellence, but that isn't good enough."

The next version of the global test will be administered in 2003.

STRUCTURAL BIOLOGY

Robots Enter the Race To Analyze Proteins



Hands off. Robot crystallographer at the Advanced Light Source's new x-ray beamline promises to solve protein structures 10 times as fast as humans can.

BERKELEY, CALIFORNIA—Structural biologists are about to get a helping hand in their effort to map the three-dimensional arrangement of atoms in proteins. Earlier this week, researchers at the Advanced Light Source (ALS) here were scheduled to begin using a new robot to automate the laborious process of mounting protein crystals in a synchrotron's x-ray beamline and then collecting and analyzing the data. Once fully operational, the robot could boost the number of protein structures that can be solved at a beamline nearly 10-fold to about 1000 per year. A similar setup is also gearing up at the European Synchrotron Radiation Facility in Grenoble, France. With these and other robotic systems now on the drawing boards, the throughput of protein structures is poised to make a revolutionary jump.

"We would like it to be so automated, you could walk away from it for days or weeks at a time," says Thomas Earnest, who is overseeing the installation of the new robotic beamline at the ALS. The automation is needed, says Earnest, because the current speed of x-ray crystallography is a bottleneck for genomics programs trying to reveal the genetics, structure, and function behind each of the body's more than 30,000 proteins. If researchers are to have a hope of doing that anytime soon, they need to industrialize the process of solving protein structures, Earnest says.

Initially, however, the robotic beamline's primary mission will be to speed drug discovery. The beamline's $2.4 million price tag has been split between the San Diego biotech company Syrrx and the Genomics Institute of the Novartis Research Foundation (GNF) in La Jolla, California. Research teams at GNF led by chemists Ray Stevens and Peter Schultz have already automated earlier steps in the crystal-making process of purifying proteins from bacteria and coaxing them into crystals. With the robotic beamline now set to go on line, "we're finally seeing everything come together," Stevens says. Once complete, Syrrx and GNF plan to use the automated systems to look at the way hundreds of different small drug candidates bind inside the active sites of different proteins, information that they can then use to design better binding compounds, Stevens says.

High-throughput studies of a wider variety of proteins should be close behind. Like all ALS beamlines, the new facility will dole out 25% of its beam time to general users (Syrrx and GNF will get the other 75%), and Earnest says teams at several other synchrotrons have already started looking into duplicating the robotic beamline at their facilities. Some groups are working to automate not only sample handling and data collection, as at ALS, but also the work of creating the proteins, purifying them, growing crystals, and processing and analyzing the x-ray data. "To be successful in high-throughput crystallography, all the pieces have to work together," says Keith Hodgson, director of the Stanford Synchrotron Radiation Laboratory in Palo Alto, California.

Although the ALS robot can't do everything, it's an important piece, Hodgson says. It houses a liquid nitrogen–cooled Dewar loaded with 64 separate protein crystals ready for analysis. Researchers sitting at a terminal outside the experimental hutch simply type in the order of crystals they want to study. The robot selects the first crystal, removes it from the Dewar, mounts it, centers it in the beam, and fires brief test pulses to find the optimal alignment for collecting data. Then, depending on the quality of the crystal, either the software instructs the beamline instruments to collect a full set of x-ray data, by tracking how the beam of x-rays ricochets off repeating planes in the crystal, or it simply moves the machine on to the next crystal.

Eventually, Earnest says, the ALS team plans to incorporate additional software packages that then automatically process and analyze the data, spitting out final

CREDITS: (TOP TO BOTTOM) T. EARNEST/BERKELEY CENTER FOR STRUCTURAL BIOLOGY; P. BAGLA

ScienceScope

Fishing for Change Fisheries scientists are bracing for what could be a stormy passage through Washington, D.C. Congress last week began work on renewing the Magnuson-Stevens Act, a 25-year-old law that aims to protect marine life from overfishing.

The law, however, has produced spotty results, experts told the House Resources Committee at a 4 April hearing. "For the fourth year in a row, the number of fish stocks that are [already] overfished, experiencing overfishing, or both has increased," noted Lee Crockett of the Marine Fish Conservation Network, which unites more than 100 science, environmental, and fishing groups. To reverse that trend, he and other advocates say Congress needs to strengthen the law—from improving habitat protection requirements to placing stricter limits on the killing of nontarget species.

Some fishing industry groups, however, say lawmakers should give existing rules—last updated in 1996—more time to work. Current law, they note, has already helped some fisheries, including New England cod and scallop populations, rebound from disaster. Expect to hear plenty from both sides over the next year, as Congress is likely to take its time weighing the arguments before acting.

GMOs Thai-ed Up Thailand has become the first Asian country to ban the release into the environment of genetically modified crops. The 3 April decision orders the agriculture ministry "to halt all genetically engineered crop field trials" and to set up a panel of scientists, farmers, and consumers to draft a biosafety law.

The action would halt ongoing field trials of Bt cotton by Monsanto, although a Bangkok spokesperson says that the government has not yet notified the company. First-year results of its Bollgard variety were "very promising," she added.

Jiragorn Gajaseni, head of Greenpeace's Southeast Asia office, hopes the decision will "encourage [other Asian countries] to follow suit." In 1999 the Thai government banned the import of genetically modified seeds for commercial cultivation but allowed imports for research purposes.

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