An unseen companion is apparently pulling it to and fro. The observation gave only a minimum mass for the companion: 0.47 times the mass of Jupiter if we are viewing the orbit edge on, which would make the companion a clear-cut planet. But if we happen to be seeing the orbit face on, the companion's mass would have to be larger—perhaps as large as a star's—to explain the wobble. In work led by Xiaopei Pan of the California Institute of Technology (Caltech) in Pasadena, an initial look with PTI seemed to reveal just such a binary companion.

Since that first work, notes Caltech's Shri Kulkarni, "we acquired considerable experience in the proper usage of PTI." The team has now found, for example, that pointlike calibrator stars must be as close as possible in the sky to the targets so that variations in the atmosphere or the instrument don't mimic a moving companion. "The new data show no evidence that 51 Peg is any different from [a] single star," according to Kulkarni. Because Pan did not accept that verdict, an outside panel led by CHARA's McAlister has examined both claims. "It's not a completely open-and-shut case," says McAlister, but the panel agreed that 51 Peg's companion is most likely a planet and not a star.

The disagreement makes a larger point, says McAlister: Interpreting data from these devices is still "a very subtle business." But with new refinements in their observing technique, the PTI team now hopes to monitor stars for side-to-side wobbles caused by planets that are too small and have too long an orbital period to be detected with the Doppler technique—planets with, say, a tenth of Jupiter's mass and a period of 10 years. "I'm pretty confident," says Queloz, who has moved to JPL to help start up the program.

In the long run, PTI is merely a test-bed for more ambitious interferometers, including one that would link the Keck I and II telescopes, separated by 85 meters on Mauna Kea in Hawaii, together with as many as four smaller "outrigger" telescopes. The interferometers built so far can't see faint objects, because they consist of small telescopes that collect little light. The 10-meter Keck mirrors will change all that. The resulting interferometer might get a direct view of objects such as the 51 Peg planet.

Looking still further ahead, JPL's Shao leads the planning for NASA's Space Interferometry Mission (SIM), a spacecraft carrying an array of telescopes that could watch stars for planet-hinting wobbles as small as 0.001 mas. "SIM will map the 'hood for all its sizable planets," out to 100 light-years or so, says Marcy of San Francisco State. The Hubble has drawn eyes to the deepest reaches of space, but the new interferometers should pick up the hot gossip of our own neighborhood.

–James Glanz

NEUROBIOLOGY

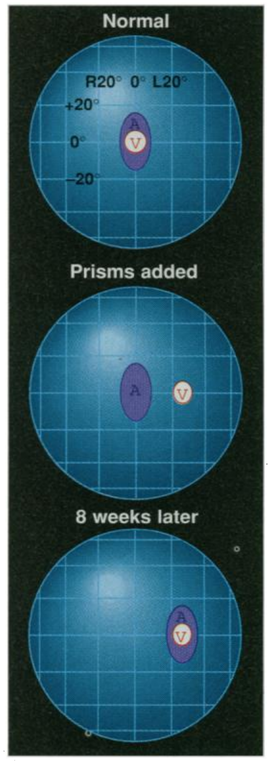
Owl Study Sheds Light on How Young Brains Learn

Consider how a child learns a second language. Whereas adults struggle to speak a new language even passably, a boy or girl can pick up a language on the street and speak it like a native for life. The young brain, it seems, is a sponge for knowledge, primed to soak up skills and information with an ease and depth it will never match again. It's a capacity that parents and teachers would do well to exploit, as cover articles in *Time* and *Newsweek* and a town meeting last year at the White House, led by Hillary Rodham Clinton, have stressed. New results now suggest an intriguing way in which the young brain may store what it learns for later use.

ANNE KNUDSEN

On page 1531, neuroscientist Eric Knudsen of the Stanford University School of Medicine reports that early experience imposes a "memory trace" on the brain that can lie dormant until adulthood and then be reactivated. Knudsen came to this conclusion from a study of barn owls that, when young, had learned to adapt to a visual field shifted by prisms fitted over their eyes. The trained birds, unlike controls, could relearn the task as adults—apparently because they had grown extra neural connections when they first adjusted to the prisms.

Beginning in the 1970s with the Nobel Prize–winning neuroscientists David Hubel and Torsten Wiesel, both then at Harvard, researchers have explored "sensitive periods" during an animal's youth, when normal neural connections are formed that produce binocular vision, depth perception, and other abilities needed throughout life. Knudsen's work goes further to show that unusual experiences can create extra links that may remain unused until much later. "This is very important, because it says there is a possibility of reactivating existing connections that were established [earlier]," says neurobiologist Carla Shatz of the University of California, Berkeley. "Even if those skills haven't been used for a long time, the learning is still there."



E. KNUDSEN AND M. BRAINARD

Wise young owl. Prisms on a young owl shift the location in visual space (V) to which optic tectum neurons respond. Over time, auditory neurons shift the locations to which they respond (A), to realign the auditory and visual maps.

Knudsen studied the ability of owls to localize sounds in space. In total darkness, an owl can pinpoint the source of a sound—such as the peep of a mouse it may be hunting—by using cues such as microsecond differences in when the sound reaches its two ears. The roots of this ability are in a brain area called the optic tectum, which contains a set of neurons that respond to both visual and auditory signals coming from particular locations, allowing the brain to merge its auditory and visual maps of space.

Owls' eyes are fixed in their sockets; the birds must move their heads to change their fields of vision. As a result, prisms placed over the birds' eyes displace the visual information sent to their optic tectum neurons. For example, if a prism shifts the visual image to the right, a neuron that originally responded to what was straight ahead is now tuned to a location to the left of center. This creates a problem for the owl: Its visual and auditory maps are out of register. "If you optically displace the visual map, you have to adjust the auditory map physiologically to bring the two maps back into alignment," says Knudsen.

In earlier work, Knudsen's team showed that preadolescent owls can do this: Within a month or so of wearing the prisms, the properties of the neurons shift so that they respond to sounds coming from the places to which the neurons are now visually tuned. Young birds can adjust to virtually any prism shift, an ability adult birds have lost.

What's more, Dan Feldman in Knudsen's lab found that the neurons form a new set of connections as they adjust. In birds wearing prisms that shift the visual image to the right by 23 degrees, each responding neuron retained its original connections from auditory neurons, but it gained a second set of connections from auditory neurons that responded to sounds from a location 23 degrees to the left. When the team removed the prisms, the young birds again adjusted their sound localization, apparently by reactivating the old connections that remained.

In the new experiment, Knudsen tested whether these previously trained birds can readjust their auditory maps to the prisms many months later, when they are well into adulthood. These birds were able to adapt, but adult birds that had never had prisms couldn't. "I put these prisms on birds that had been without prisms for half a year, which is a long time in bird life, and—*Voilà*!—3 weeks later, I saw this neural learning appear," says Knudsen. "In the normal adults, you'd never see it happen."

The prior prism exposure did not give the adults the same wide-open adaptability of young birds. Although they could relearn what they had mastered when they were young, they could not adjust to prism shifts of other directions or magnitudes. That suggested they were limited by the connections they had grown earlier to accommodate the 23-degree rightward shift. The birds seem to "go back and use the old anatomy," says Jon Kaas, a neuroscientist at Vanderbilt University in Nashville, Tennessee. "You can actually understand this in terms of altered anatomy of the system."

Although his data are entirely consistent with the reactivation of the old connections, Knudsen hasn't shown directly that the connections persist in older birds. But if tests he plans to do this year confirm that the connections remain, his system will allow researchers to ask new questions. Neurobiologist Michael Stryker of the University of California, San Francisco, proposes two: "What is it that causes these connections to be turned off after they are no longer useful, and yet to remain there? And what turns them back on again?"

Even if it turns out that the physical connections don't endure into adulthood, says Berkeley's Shatz, the owls' early experience must leave some relic that explains why they can relearn the prism shift. Knudsen's system, she says, "represents a fantastic opportunity to study what the enduring trace of that early experience is."

Many neuroscientists expect that what Knudsen has found in the brains of barn owls will generalize to learning in the brains of other animals, including humans. It all reinforces what Hillary Clinton and the news magazines have been telling us: that exposing our kids to more experiences at a young age may make them smarter adults. Indeed, it may physically lay down the pathways for achievement later in life.

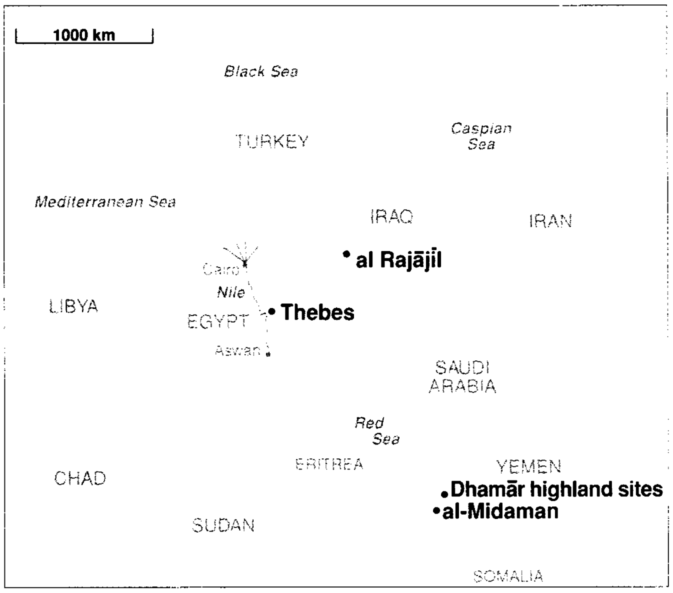
–Marcia Barinaga

ARCHAEOLOGY

Yemen's Stonehenge Suggests Bronze Age Red Sea Culture

For decades, classical archaeologists focused much of their attention on the Mediterranean Sea, where Egyptian stelae, Minoan friezes, and Turkish shipwrecks reveal the rise and fall of empires and the skein of sea trade among them. Now, new excavations are offering the first, tantalizing glimpse of an ancient civilization that flourished 4000 years ago near another major Old World waterway: the Red Sea. Work by researchers from several different countries on the Red Sea's arid southeastern coast points to a complex culture whose people enacted costly rituals, possessed metal tools, and raised daunting megaliths at about the same time as Stonehenge appeared in Great Britain.

In research currently in press in the *Proceedings of the Seminar for Arabian Studies*, Edward Keall, head of the Department of Near Eastern and Asian Civilization at the Royal Ontario Museum in Toronto, presents preliminary evidence for a previously unstudied Bronze Age culture in coastal Yemen. His team members found the ruins of a circular prehistoric religious site, or henge, built of granite pillars weighing 20 tons. Buried at the foot of a fallen megalith, they discovered a cache of copper-alloy tools dated to between 2400 and 1900 B.C. And nearby, they unearthed fragments of children's skeletons from what appeared to be ceremonial burials. All this suggests a well-organized people living in an arid coastal plain once thought to have been almost empty at this time. "People had assumed that there was nothing there during the Bronze Age," says Keall.



Bronze Age networking. Discoveries at al-Midaman raise the possibility of trade between the famous Mediterranean cultures and those along the Red Sea coast.

Other experts say the finding should draw attention to the dozen or so similar stone pillar sites scattered across western Arabia. "These sites have been sort of looked at, but not very thoroughly," says Christopher Edens, a research associate in the Near Eastern section at the University of Pennsylvania Museum. "Now, someone has actually investigated these things and found this cache of bronzes, which is phenomenal for this area. I was floored." Moreover, the new excavation, which has yielded the first date for these mysterious megaliths, raises the possibility that an ancient and unsuspected trade network operated along this stretch of Red Sea coast.

Keall stumbled on the site, known today as al-Midaman, in March 1997, while transporting gear from work on a nearby medieval port. Taking a wrong turn along a local road, he encountered a date farmer, who led him to three granite pillars standing in roughly a straight line and towering nearly 3 meters above the desert sands. Other pillars, some granite and some of basalt, lay eroding on the ground or buried in the sand. "Stonehenge was the only thing I could think of," says Keall.

There are a dozen or so similar monuments in Saudi Arabia and Yemen, but until now only one—Rajājīl, in northwestern Saudi Arabia—had been excavated. Studied in the late 1970s, this dig was a disappointment, yielding no grave goods or bones and virtually no cultural material. And although relics of agricultural people from this time are known in the Yemen highlands, these sites yielded almost no metal, as might be expected of Bronze Age sites.

Keall, however, was fascinated by the standing stones. With the nearest granite