its moon Charon.

The project also needs $122 million next year for a 2006 launch, which depends on a gravity assist by Jupiter. And even with the necessary funding—NASA requested nothing this year—agency officials worry that the mission might not be able to test the new launch vehicle and win approval of the radioactive thermal device needed to power the spacecraft's electrical system in time. An innovative solar electric engine could allow for a later launch, but Stern says that the change would add complexity and cost.

A Europa mission is even more uncertain, despite being ranked first in what would be a series of large new spacecraft. "I'm happy to have [a large mission] identified, but the office of space science has absolutely no money for it," says Colleen Hartman, NASA's solar system exploration chief. The Jet Propulsion Laboratory in Pasadena, California, has been working on a Europa mission, which is now on hold after its estimated cost doubled to nearly $1 billion.

The most surprising recommendation, researchers say, was the one that listed a sample return mission to the moon's Aitken Basin as runner-up in the medium class. The basin is the largest known impact basin in the solar system and could yield old rocks from deep in the mantle without extensive drilling. The subcommittee that examined inner planets research preferred a flight to Mercury—a project well under way—and an atmospheric and surface study of Venus. But the full committee overturned that ranking, Belton says, on the grounds that a lunar sample return could provide good science and lay the groundwork for Mars and Venus sample returns. A comet sample return, widely considered a priority within medium-class missions, came in last because of the greater interest in planetary exploration.

The subcommittee panel handling Mars research concluded that a sample return starting in 2011 was the top priority. But the full committee, cognizant of a price tag of $2 billion or more, overrode that recommendation. Instead, it suggested a date between 2013 and 2023, prodding NASA to seek foreign partners. The group kept NASA's existing Mars exploration plan intact through the end of this decade.

The report endorsed NASA's plans to develop technologies for faster and smaller spacecraft, including nuclear propulsion. It also urged the agency to contribute half of the cost of a ground-based Large-Aperture Synoptic Survey Telescope being developed by the National Science Foundation so that it could carry out solar system observations as well as all-sky surveys. Money should be set aside to upgrade NASA's Deep Space Network, which gathers distant spacecraft signals, the report added, and for a planetary data system to archive the vast amounts of data being generated.

The panel didn't calculate the cost of these missions and upgrades, which remains a critical question for NASA. Burns believes that much of the report's recommendations "realistically fall within the envelope of future planned expenditures," but NASA officials privately are skeptical. With a jittery economy and other pressing national concerns, NASA will need lobbying muscle as well as NRC's wish list to get the solar system train rolling. **–ANDREW LAWLER**

FORMER SOVIET UNION

Armenia Gears Up For Synchrotron

YEREVAN—This decrepit building on the outskirts of Armenia's capital doesn't look like much now, but in a few years' time it might be abuzz with activity as the headquarters for a gleaming new research facility the size of a football field: a $48 million, 3-giga-electron-volt (GeV) synchrotron. Backed by an unlikely alliance of high-energy physicists and a New Jersey homebuilder, it will be one of the biggest single scientific assistance projects ever undertaken in the former Soviet Union (FSU) if it goes ahead.

CANDLE power. Construction magnate Jirair Hovnanian (*far right*, with Armenian President Robert Kocharian) helped secure down payment from the United States for a synchrotron in a building near Yerevan (*above*).

CREDITS: (TOP TO BOTTOM) MUTSUMI STONE; J. HOVNANIAN

Earlier this month, the U.S. Department of State asked a special panel to review design plans for the project, called the Center for the Advancement of Natural Discoveries using Light Emission (CANDLE). Backers portray CANDLE, which would generate intense beams of x-rays and ultraviolet light for everything from protein crystallography to materials science, as manna for the Caucasus region's impoverished scientific community. It would be the first of today's third-generation synchrotrons to appear in the FSU and the only such facility within a radius of 2000 kilometers. And despite the machine's far-flung location, some foreign scientists are looking forward to working on it. "One can carry out experiments at CANDLE very easily that will be more difficult here," says Josef Hormes, director of the Center for Advanced Microstructures and Devices, which hosts a less powerful synchrotron at Louisiana State University, Baton Rouge.

The project is also a stunning example of overseas pork-barrel politics—a fact not lost on some observers of FSU science, who wonder how many researchers will end up using the facility. First, however, the review panel must approve the design, then $15 million of the State Department's foreign aid for Armenia would be released to the project. But CANDLE researchers must raise at least $30 million more to finish the synchrotron and the first five beamlines and labs, then come up with $4 million a year to operate the facility if it comes online as planned in September 2007.

Much of the credit for kindling CANDLE belongs to Jirair Hovnanian, a 75-year-old construction magnate from New Jersey. In a Philadelphia church in December 1999, Hovnanian met, by chance, a Stanford physicist who described Armenia's hopes to acquire the mothballed BESSY I synchrotron, which was being offered by Germany as the centerpiece for a new international research center in the Middle East, dubbed SESAME. Armenia had good credentials to host SESAME: In Soviet times the republic was a physics stronghold and in the 1960s built a 6-GeV synchrotron. Hovnanian saw SESAME as a major prize for his compatriots, but he discovered to his dismay that Jordan was the front-runner to host it.

The wealthy Iraqi-born Armenian-American swung into action. He persuaded SESAME's overseers to agree that if Jordan failed to find funds to house and upgrade BESSY, then the synchrotron would go to

Armenia. Next he lobbied the formidable Armenian Caucus in Congress. The result: $15 million of the State Department's 2001 budget was earmarked for SESAME or "a comparable project" in Armenia.

Even as Jordan was struggling to make its case for SESAME, Hovnanian made a surprise announcement in November 2000: Armenia would instead build a synchrotron from scratch. Physicists in Yerevan, he says, had convinced him that "they could build a bigger and better machine for less money." CANDLE got extra clout the following spring when prominent high-energy physicist Alexander Abashian, recently retired from Virginia Polytechnic Institute and State University in Blacksburg, was appointed project director.

If CANDLE secures its U.S. grant, Abashian hopes to begin construction in 2004. For the rest of the funding, "we'll target everyone we can," he says, including U.S. government sources and nonprofits that support FSU science. Provided the fundraising succeeds, CANDLE might still have trouble luring users to Yerevan. One reason that Armenia wasn't chosen to host SESAME is its "difficult accessibility," says Herwig Schopper, who heads SESAME's interim council. "Jordan is much more centrally located," he says. (BESSY I arrived in Jordan earlier this month and is expected to be operating by 2006.)

Still, CANDLE technical director Vasili Tsakanov expects "broad participation" from the Middle East, Russia, and other FSU countries. And scores of Armenian scientists could be called on to do contract research. "If somebody doesn't want to come to Armenia, we will do the research for you," Hovnanian says. "This is an investment that would benefit the world, not just Armenia."

–RICHARD STONE

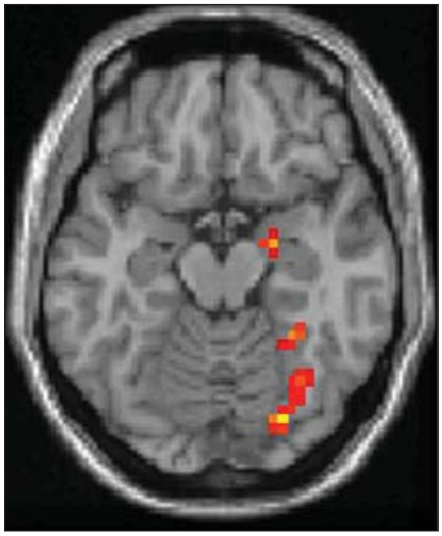
NEUROSCIENCE

Gene's Effect Seen in Brain's Fear Response

The saying "like father like son" reflects the common assumption that temperament, like eye color and pattern baldness, can be passed on in the genes from one generation to the next. But demonstrating how genes influence behavioral traits has been much more difficult than tracing the lineage of physical characteristics.

A study on page 400 might provide a tantalizing glimpse of things to come. A team led by psychiatrist and neurologist Daniel Weinberger of the National Institute of Mental Health in Bethesda, Maryland, has shown that people with different versions of a single gene have different patterns of brain activity in response to emotion-laden stimuli.

The findings demonstrate that individual genes can contribute to how the brain interprets its environment, Weinberger says: "How that translates into a person's perception of the world is a much more complex question, but I think we'll be able to understand how genes contribute to emotionality, temperament, and psychiatric illness by understanding how they contribute to information processing in the brain."



CREDIT: A. HARIRI *ET AL.*

Yikes! A single gene appears to modulate the amygdala's reaction to emotional faces.

"It's a fascinating study," says Joseph LeDoux, a neuroscientist at New York University. "It will surely stimulate lots of additional work on the neural basis of normal and pathological fear and anxiety."

The gene in question encodes a transporter protein that shuttles the neurotransmitter serotonin back into neurons after it has been released, thus limiting serotonin's effect on neighboring cells. The gene comes in two common versions, or alleles. One contains a short promoter region, the stretch of DNA that controls the gene's expression; the other has a longer promoter. In cell culture experiments, the short allele produces only about half as much of the transporter as the long allele, but the jury is still out on whether this difference exists in vivo. One hint that the transporter gene influences behavior comes from the finding that people who have a copy of the short allele—about 70% of the population in North America and Europe—are slightly more likely (3% or 4%) to show signs of anxiety or fearfulness on clinical personality tests than those with two copies of the long allele.

Weinberger's team reasoned that the gene's effect might show up more clearly in patterns of brain activity—particularly in an almond-shaped region of the brain called the amygdala, the brain's emotional command center. The researchers used functional magnetic resonance imaging to monitor activity in the amygdalas of 28 volunteers, half of whom had two copies of the long allele and half of whom had at least one copy of the short allele. While being scanned, subjects saw a picture of a face with either an angry or frightened expression and then had to choose which of two other faces showed the same emotion.

Both groups matched expressions correctly about 90% of the time. But people in the short-allele group showed considerably more activity in their right amygdalas while engaged in the task. There was no difference in brain activity when subjects had to match shapes. Many studies have shown that the amygdala revs up in frightening situations, Weinberger says, and the heightened activity in the short-allele group might help explain why, at the population level, people with the short allele are more prone to anxiety. "The amygdala puts a label on information that says 'This is dangerous,' " he explains, and a hyperactive amygdala—perhaps resulting from less serotonin transporter—might make people feel threatened even in nonthreatening situations.

Researchers say the study is one of only a handful to link a genetic variation to differences in brain activity. "It is a true milestone in psychobiological research and behavioral genetics," says psychiatrist and neuroscientist Klaus-Peter Lesch of the University of Würzburg in Germany, whose group discovered the two alleles of the serotonin transporter.

Still, some caution that the study doesn't prove that the difference in amygdala activity is caused by a difference in serotonin function. "To make the demonstration complete, it would have been so nice to measure aspects of serotonin transmission," says Chawki Benkelfat, a research psychiatrist at McGill University in Montreal, Canada. Even so, the new study puts researchers one step closer to understanding how small genetic differences might shape the way people respond to the world. –GREG MILLER

FOOT-AND-MOUTH DISEASE

Report Urges U.K. to Vaccinate Herds

LONDON—Britain's top scientific body has urged the government to abandon its longstanding practice of relying solely on slaughtering animals to combat future outbreaks of foot-and-mouth disease (FMD). Instead, in a report released 16 July, a Royal Society panel has concluded that vaccination and improved data collection should result in better control and fewer dead animals.

The use of vaccination to control FMD