November. "They've promised us more cooperation only if NCI spends more money in Russia," grouses one DOE official.

At the proposed level of funding, "it will be very difficult, if not impossible, to sustain a viable program," says William Hoehn III, director of the Washington, D.C., office of the Russian-American Nuclear Security Advisory Council, a bilateral think tank. He and other observers hope, however, that a fledgling European initiative can pick up some of the slack. This Italian-led effort, which will focus on environmental and energy-efficiency projects, has just started raising funds from European nations.

The NCI is not the only imperiled part of DOE's year-old long-term Russian nonproliferation initiative. The Administration's proposed cuts would, among other things, eviscerate DOE's efforts to help manage Russia's 30 tons of plutonium extracted for fuel at civilian power plants and shelve research on a geological repository for spent fuel—a Russian version of Yucca Mountain. The cuts would also eliminate an effort to set up an unclassified database of Russia's plutonium stockpile. "The consequences of these cuts are quite substantial," asserts Bunn. Adds Hoehn, "It sends a signal to me that these efforts are simply not going to be a priority security issue for the Bush Administration."

Some experts argue, however, that the money for programs like MPC&A and NCI would be better spent "disrupting nuclear deals in the making where possible," as Lee puts it. He advocates stepping up intelligence gathering on so-called rogue nations like Iraq and North Korea and increasing border surveillance, while ending the economic and diplomatic isolation of these states "to undercut the strategic rationale" for developing weapons of mass destruction. Many other experts concur that intelligence operations must be strengthened. "We need to know in more detail what kind of actors are doing what," says Lars van Dassen, director of the nuclear nonproliferation program at the Swedish Nuclear Power Inspectorate. Others argue that although both kinds of activities are urgently needed, "the best hope is to secure the materials so they are never stolen in the first place," says Bunn.

Diplomacy: the missing voice

While the United States debates the future of its nonproliferation efforts, other countries are looking for ways to strengthen international treaties and programs. Experts are now discussing how to tighten accounting under the Convention on the Physical Protection of Nuclear Material, which binds signatories to track exports and imports of weapons-grade uranium and plutonium. The United Nations is weighing new ideas and might consider a Russian antiterrorism measure that would ask states to improve physical controls on all nuclear materials. Another far-reaching scheme is taking shape within IAEA. Physicist Moustafa Bahran, chair of the National Atomic Energy Commission of the Republic of Yemen, is lining up support for a voluntary program to tag and track high-risk materials. He intends to propose it at the next IAEA general conference in September.

Over the next few months, however, the focus will be on the United States. The Administration's defense and nonproliferation policy is expected early this month, and Congress will debate the budget proposals throughout the summer. Provoking the most concern, perhaps, is the apparent rudderlessness of the U.S. nonproliferation strategy. "There's nobody in charge at the moment," says Bunn. What's needed, he argues, is someone who would report directly to the president and oversee nonproliferation efforts across the government. "I'm absolutely convinced that if the president went to Congress with a plan, we'd see substantial funds for nonproliferation efforts," Bunn says. Without such a plan and the money to implement it, the cat-and-mouse game between nuclear traffickers and border guards at Dostyk and other remote corners of the world may shift in favor of the smugglers—leaving the world a far riskier place. **–RICHARD STONE**

MEETING LANGUAGE, BRAIN, AND COGNITIVE DEVELOPMENT

What Makes the Mind Dance and Count

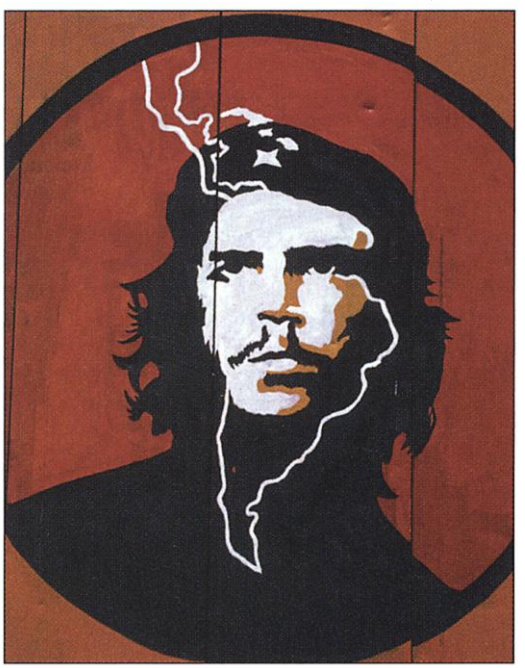
PARIS—Four dozen leading cognitive neuroscientists met here at the Collège de France from 3 to 5 May to share their latest data on topics such as amusia—an inability to perceive music—and number sense in infants. The "Language, Brain, and Cognitive Development" gathering was held in honor of Jacques Mehler, founder of the journal *Cognition*, who will soon retire from CNRS.

Wired for Sound, Not Music

Che Guevara was widely recognized as a man of many talents. Yet one talent the 1960s revolutionary lacked was the ability to hear music, a shortcoming he was acutely aware of. According to one account, Guevara was at a party one evening when he spotted a nurse he wanted to dance with. He asked a friend to give him a nudge when the orchestra struck up a tango. But the friend got the signal mixed up, sending Guevara out on the dance floor to dip and swirl his partner absurdly to the tune of a soft Brazilian samba.

Guevara suffered from congenital amusia, a nearly total tone deafness that turns music into mere noise. Although 5% or more of some populations suffer from this syndrome, it has not been widely studied. At the meeting, Isabelle Peretz of the University of Montreal reported preliminary results with amusical subjects that may support the hypothesis that the brain contains specific neural pathways for music.

Peretz studied 11 amusical adults who had a high level of education, didn't have any loss of hearing or other obvious neurological impairments, and had tried to take music lessons when children and thus had been exposed to music from an early age. These individuals, along with 67 control subjects, were given a battery of tests for musical ability and other cognitive skills, such as language ability. Most members of the amusical cohort were unable to detect when a tune, such as "Happy Birthday," was played with pitch alterations that made it clunk in the ears of the



Too tone-deaf to tango. Che Guevara.

CREDIT: TOM BEAN/CORBIS

control subjects. One typical case, Peretz says, was that of "Monica," whose IQ measured 111 and who was working on a master's in health sciences. Despite functioning normally in all other areas of mental life, Monica could neither recognize nor sing familiar tunes such as "Frère Jacques," even though as a native of French-speaking Quebec she had been exposed to the song since infancy. The only nonmusical impairment that Peretz and her Montreal co-workers were able to identify was a decreased ability of some subjects to detect prosody, or pitch variations, in normal speech.

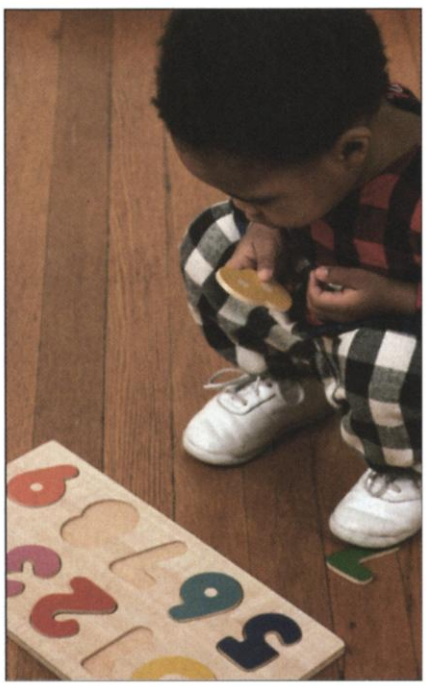
Thus, aside from impairing their singing and dancing skills, amusia may have seeped into some subjects' language abilities as well. Peter Jusczyk of Johns Hopkins University in Baltimore and others caution that this prosody deficit might complicate a neat picture by indicating a neural linkage between music and language pathways. "I would like to see better evidence that amusia can be fully disentangled from prosody in language," says Jusczyk. "Prosody, after all, refers to the musical aspect of language."

Despite the spillover between pure music comprehension and sensitivity to the subtle music within speech, Peretz concludes that her results and those from other studies are consistent with the idea that "there must be specialized neural systems for music," which amusical people lack from birth. Indeed, the notion that musical ability is hardwired into the brain has recently received support from studies of identical twins (*Science*, 9 March, pp. 1879 and 1969). Also bolstering this conclusion, Peretz says, are studies of brain-damaged patients who have lost their musical abilities, as well as studies of people with "musicogenic epilepsy," a rare condition in which seizures are triggered by music. Peretz says her team will now turn to techniques such as magnetic resonance imaging to try to pin down exactly where in the brain these neural circuits are located.

Peretz's study is receiving high marks. "There is a very strong case for specific neural pathways," says Uta Frith of University College London. But the findings beg the question of what adaptive purpose such hardwiring might serve. In several recent articles, Peretz has argued that the ability to hear music is an adaptation possibly designed to increase social cohesion among groups by providing them something to share. But some of her colleagues are skeptical. "She has provided compelling evidence that there are [neural] pathways for music," says Steven Pinker of the Massachusetts Institute of Technology in Cambridge. "But whether they were selected in the course of human evolution as opposed to being a byproduct of ... pathways that evolved for other purposes is still an open question."

Born to Enumerate?

Albert Einstein, describing how he arrived at such highly mathematical concepts as the theory of relativity, once wrote: "Words and language ... do not seem to play any part in my thought processes." For some cognitive scientists, such perceptions support the notion that our brains are equipped with a built-in "number sense," independent of language or other symbolic functions. At the meeting, Stanislas Dehaene of the French Atomic Energy Commission's neuroimaging lab in the Paris suburb of Orsay presented new evidence for this hypothesis from studies of infants.



Count me in. New data support the hypothesis that babies are born with an innate "number sense."

Dehaene has long argued that our ability to perform calculations is rooted in two distinct brain regions. Exact arithmetic, he claims, is a cultural invention requiring number symbols—such as 1, 2, 3—and these calculations are carried out in left-hemisphere circuits also used for language. But approximate arithmetic, corresponding to a general number sense that has evolved in humans and some animals, is independent of language and can be mapped to parietal lobe circuits (*Science*, 7 May 1999, pp. 928 and 970). Dehaene has found support for this arithmetic duality in research he and other neuroscientists have conducted that demonstrates that babies, monkeys, and even rodents can distinguish numbers. Additional evidence comes from brain-damaged patients who have lost their ability to do arithmetic.

The new studies, which Dehaene carried out in collaboration with Ghislaine Dehaene-Lambertz of the French national research agency CNRS in Paris, investigated alterations in electrical activity in the brains of 4-month-old babies exposed to changes in number patterns. The babies' heads were covered with a light mesh made up of 64 electrodes. In the first stage of the experiments, the researchers presented numbers to the babies as tones, flashes of light, or spoken syllables. For example, the number 2 could be represented by two tones in quick succession. The electrodes recorded the resulting event-related potentials (ERPs) in the babies' brains.

In previous work on the ability of babies to distinguish spoken syllables, the pair had found that one ERP peak increased significantly whenever a novel syllable was heard. In the new studies of number sense, they found a similar effect. A peak that arose about 750 milliseconds after the stimulus decreased in intensity if the baby was repeatedly exposed, or habituated, to the same number—for example, the tones beep-beep, beep-beep, beep-beep. But if the last in the series of numbers was changed—such as beep-beep, beep-beep, beep-beep-beep—this peak shot back up to its prehabituation level. The effect was independent of the stimuli (tones, flashes, or spoken sounds), even if the stimuli were mixed in the same experiment—indicating, Dehaene said, that the babies were responding directly to changes in number.

Dehaene and others at the meeting interpret these results as further support for the idea that humans possess an intrinsic number sense long before they can speak or perform calculations. "These studies are wonderful," says Elizabeth Spelke of the Massachusetts Institute of Technology. "They fit in beautifully with the ensemble of evidence ... that there is a [brain] domain–specific, dedicated system for processing approximate [numbers]."

Such findings may help provide clues to the evolutionary origin of number sense. Dehaene's study "parallels very nicely the work on animals," says Marc Hauser of Harvard University, who presented similar results at the meeting from experiments on cotton-top tamarin monkeys. And Spelke praises the use of ERP measurements as a step forward in the study of how cognitive processes in babies develop, work that in the past has relied heavily on behavioral indicators such as how long an infant spends gazing at a stimulus: "This is better data than from virtually any of our behavioral methods to study infants."

—MICHAEL BALTER

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