procity, such as Trivers's reciprocal altruism, can account for the results. For his part, Trivers says the data are intriguing but don't require new theories: "It's absurd—and I use that word advisedly—to imagine that we've evolved to respond to the specific situations that these economists put us in, with complete anonymity and no chance to interact with partners a second time."

Even though lab experiments may be artificial, they appear to elicit deeply conflicting responses in the brain. Last year, neuroscientist Alan Sanfey of Princeton University and his colleagues reported using functional magnetic resonance imaging (fMRI) to observe the brains of people playing the ultimatum game (*Science*, 13 June 2003, p. 1755). Unfair offers of 20% of the pie prompted a reaction from the bilateral anterior insula, a part of the brain activated during unpleasant experiences such as pain, hunger, or thirst and emotions like anger and disgust. Those with stronger activation of this area were more likely to reject the unfair offer. A second area, the dorsolateral prefrontal cortex, was also activated. It is linked to rational, problem-solving processes. The authors theorize that the dilemma faced by someone presented with an unfair offer prompts conflict between the two brain areas: Should I accept the smaller sum, and at least end up with something, or should I refuse and punish the selfish partner? Subjects with greater activation of the prefrontal cortex were more likely to accept even unfair offers.

In this week's issue of *Neuron*, Tania Singer and her colleagues at the Wellcome Department of Imaging Neuroscience in London describe fMRI studies of people playing a cooperation game called the sequential prisoner's dilemma. After the game, seeing faces of cooperative partners triggered increased activity in brain areas linked to social cognition and reward. Fehr and his colleagues have also measured the activation of brain regions when game participants have the chance to punish those who don't cooperate. In preliminary results, the opportunity to punish seems to activate similar kinds of reward-related pleasure circuits as does eating sweets. "We call it the 'sweet taste of revenge,'" he says.

On a more troubling note, the desire to punish unfairness could help drive irrational acts such as suicide bombings, says Gintis. Some people are willing to pay an extremely high price as long as they can inflict serious suffering on those they consider an enemy. "If such behavior is present in a controlled, cool lab situation, it is even more likely that it is an important force in the real world," Gächter says.

A sensitivity to "fairness" may have emerged early in the primate lineage. In a paper published in August 2003 in *Nature*, Sarah Brosnan and Frans de Waal of Emory University in Atlanta, Georgia, and their colleagues showed that capuchin monkeys have a keen sense of fairness. Brosnan gave a monkey a pebble, which it was supposed to return to her in exchange for a slice of cucumber. Most monkeys were perfectly content to trade the pebble for a cucumber, but when they could see a neighboring monkey perform the same task and receive a grape—a much more valued treat—in return, monkeys refused the cucumber even though the alternative was no reward at all. In recent work, chimpanzees have shown similar reactions, Brosnan said at the Göttingen meeting. "A test for fairness is probably hardwired," Gächter says.

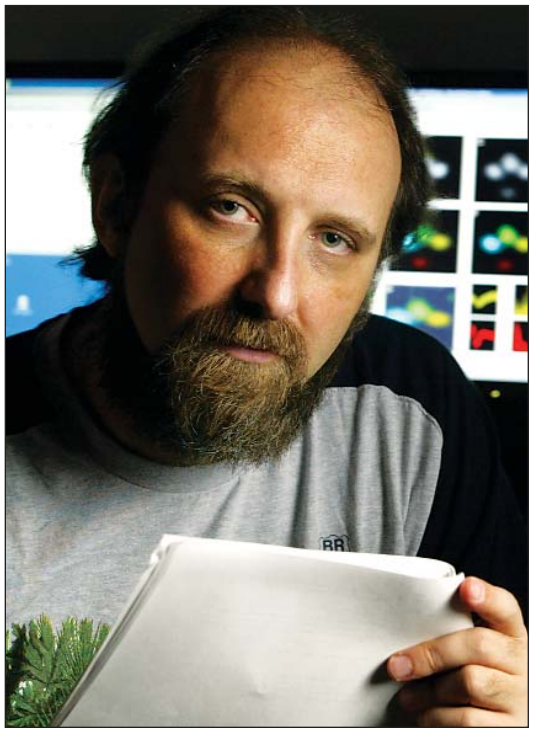
With so many cooperative tendencies built into human brains, whether by genes or culture or both, why isn't there more harmony in the world? Unfortunately, notes Boyd, one of humans' most successful cooperative endeavors is making war. "All that increased cooperation has done is change the scale on which conflict takes place," he says. "I would like to think there's a happy story of peace and understanding. But you can't be a 21st century human and not see that the trend is in the other direction." —GRETCHEN VOGEL

Profile Miguel Nicolelis

Brazil Institute Charts a New Hemisphere for Neuroscience

Brazilian-born neuroscientist Miguel Nicolelis has an ambitious plan to create a novel research institute in a poor region of his native country

Duke University neuroscientist Miguel Nicolelis's social conscience was pricked whenever he used the plush athletic complex at the University of São Paulo as a medical student in the 1980s. The sports facilities were off-limits to neighborhood children, who had to make the best of their congested, urban setting. The disparity so disturbed Nicolelis and his friends that they created an after-hours sports school, giving local children a chance to use the university facilities—and to learn the value of teamwork, fair play, and working toward a goal.



Science with a social bent. Miguel Nicolelis plans to establish a clinic and a school along with a neuroscience research center.

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Two decades later, the school still exists, and some of those who played soccer and capoeira, a traditional Brazilian sport that mixes dance and fight, have gone on to attend university and launch successful careers. Now Nicolelis wants to apply his professional expertise and social conscience to a much bigger challenge: Brazil's underdeveloped northern region. His dream is to create a world-class neuroscience research institute on the outskirts of Natal, the state capital of Rio Grande do Norte and its largest city, and with it a mental health clinic, an elite community school, and a science museum.

The Brazilian government has donated a scenic 100-hectare plot of land in the hills overlooking the city, which hugs the Atlantic Ocean. It's also contributed most of the $1.5 million that Nicolelis has raised toward a target of $30 million by 2006 for the entire complex. Next month more than 300 neuroscientists from around the world will converge on Natal to talk about their latest research (natalneuroscience.com)—and how they can help the

International Institute for Neuroscience of Natal (IINN) become a reality.

"Yes, we want the institute to be a center of excellence for Brazilian neuroscience," says the 42-year-old Nicolelis, who came to the United States 15 years ago as a postdoc. He has since earned international recognition for translating electrical signals in monkey brains into commands that drive robot arms—work that he and his colleagues hope will lead to clinical trials later this year of prostheses for paralyzed people. "But the key to the whole concept is the social mission attached to the institute," he says. "That's what appeals to the Brazilian government. A group of us had been talking about doing something like this for a long time. And with the election of the new president [Luiz Inácio Lula da Silva in October 2002] and his promise to enhance Brazilian science, we saw an opportunity to move ahead."

IINN was officially created last spring by Nicolelis and two other expatriate neuroscientists: Duke's Sidarta Ribeiro, his postdoc, and Claudio Mello of Oregon Health and Science University in Portland. Nicolelis is chair of a star-studded advisory group that will oversee the institute's scientific activities. Next month's conference will also mark the first meeting of the institute's board of trustees, a group of Brazilian political and scientific leaders, leavened with distinguished foreigners, who will set overall policy and raise money for the project.

"Miguel is a life force, an outstanding researcher with a strong entrepreneurial streak who's very committed to the cause," says Peter Lange, Duke's provost and an IINN trustee. Duke has put up $50,000, in part to support a laboratory at nearby Federal University of Rio Grande do Norte through which the institute will eventually offer doctoral degrees. The Pentagon's Defense Advanced Research Projects Agency, which has funded Nicolelis's work at Duke, has chipped in $40,000 for the conference.

But the institute still faces a long, hard road. One major obstacle, say Brazilian scientists with experience on other international projects, is the fickle nature of Brazilian funding sources. Ivan Izquierdo, a neuroscientist at the Federal University of Rio Grande do Sul in Porto Alegre, notes that he's still receiving money from a 3-year federal grant awarded in 1997 because it took several years for the funds to begin flowing. "When it comes to science, Brazilian funding agencies have a long tradition of noncontinuity," he says.

Even after the tap is turned on, however, the country's stifling import regulations can soak up those resources. "To give you an idea of how bureaucratic the process is, an electrophoresis apparatus that I ordered as an undergraduate was held up by customs until the end of my Ph.D.," says Stevens Kastrup Rehen, a Pew Fellow at the Scripps Research Institute in La Jolla, California, and an associate professor at the Federal University of Rio de Janeiro.

Field of dreams. This site overlooking Natal, which was donated by the Brazilian government, will be home to the International Institute for Neuroscience of Natal.

Nicolelis and his colleagues have heard the horror stories. But they insist that times have changed. Last month the institute set up shop in a nondescript office building in Natal. It will serve as temporary quarters until a move to its permanent home in nearby Macaiba, an impoverished farming town that Nicolelis hopes will be transformed into a showcase community.

The first example of that transformation will be a health clinic. Among its services will be the sort of blood tests on newborns that are routine in major cities but unknown in the rural areas outside Natal, he says. Next year should also see the debut of a school that provides free, topflight education for neighborhood children and their parents, many of whom are illiterate. "We'll hire teachers from all over and pay salaries comparable to the best private schools," Nicolelis promises. "I'm already getting queries from scientists who want to move to the university so that their kids can go to the school."

Building the research institute itself, he predicts, "will be our hardest job." Current plans call for 25 laboratories, 15 for staff scientists and 10 for collaborative work with researchers from around the world. Nicolelis hopes that the institute will serve as the vehicle "for a generation of Brazilian scientists to come back home." At the same time, he expects that about one-fourth of the professional slots will be filled by non-Brazilians; the director will be chosen through a worldwide search. And although federal and state governments may provide much of the money, Nicolelis says, they won't be calling the shots: "I've made it very clear that we are going to run ourselves."

But not with Nicolelis at the wheel. Although he plans to spend considerable time in Natal helping the institute get off the ground, he has no interest in becoming its director. In fact, once IINN is both financially and scientifically secure, Nicolelis would like to clone the concept in other underdeveloped parts of the country. "We have a list of 10 topics," he says, including genetics, agriculture and food production, nanotechnology, and environmental science.

His hope of spreading Brazil's scientific resources outside the twin hubs of São Paulo and Rio de Janeiro, he says, meshes with President Lula's promise to foster economic development in the hinterlands. But the name chosen for the institutes' umbrella organization—Alberto Santos Dumond Foundation—underscores the project's central challenge. Santos Dumond, an aviation pioneer and national hero, "is by far Brazil's most successful scientist," Nicolelis asserts. But outshone by the Wright brothers and unsung outside his own country, he is also a reminder of how far Nicolelis and his colleagues must go to make a lasting mark on global science.

–MARCIA L. TRIUNFOL AND JEFFREY MERVIS

Marcia L. Triunfol is on the staff of *Science*'s Next Wave.

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