Not like us. Even smart animals are "whoppingly different" from humans, a researcher asserts.

How Human Intelligence Evolved—Is It Science or 'Paleofantasy'?

BOSTON, MASSACHUSETTS—Richard Lewontin knows how to grab an audience's attention. Lewontin, an evolutionary biologist at Harvard University, led off a session titled "The Mind of a Toolmaker" by announcing that scientists know next to nothing about how humans got so smart. "We are missing the fossil record of human cognition," Lewontin said at the meeting. "So we make up stories."

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Not so, responded other human evolution experts on the interdisciplinary panel. "Thanks to continuing research in comparative psychology, genetics, neuroimaging, and paleoanthropology, we know plenty about the evolution of human cognition," said anthropologist Dean Falk of Florida State University in Tallahassee. In rebuttal to Lewontin's complaints about a meager fossil record and the dangers of inferring cognitive capacity from indicators such as skull size, they cited research that they say provides important—if indirect—insights into uniquely human mental capacities.

Geneticist Christopher Walsh of Harvard Medical School thinks some answers to the mystery of human cognition lie in genes that govern brain development in modern human beings. Ongoing work in his and other laboratories has shown that mutations in a number of these genes lead to microcephaly, characterized by a very small brain and mild to severe retardation, and other brain malformations. Tests for "signs of selection" have shown that some of these genes were targets of natural selection during human evolution.

Walsh described recent research suggesting that a well-studied gene called *ASPM* controls the fate of embryonic nerve cells in the multilayered cerebral cortex. The cells must divide in the correct orientation and at the right time as each cortical layer takes form. Selection for changes in *ASPM*, Walsh said, "may provide an evolutionary mechanism that can enlarge the cortex" and help explain the dramatic expansion of hominid brains that began about 2 million years ago.

Anthropologist Leslie Aiello, president of the Wenner-Gren Foundation for Anthropological Research in New York City, agreed that current research can "get us beyond the paleofantasy that Richard Lewontin is talking about." Aiello argued that the fossil and archaeological records are strong enough to show several "major phases in human evolution," including the split between the chimpanzee and the human lines about 6 million years ago and the invention of stone tools beginning about 2.5 million years ago. Moreover, Aiello said, sophisticated reconstructions of ancient climates have matched evolutionary events with environmental changes. "Our evolution has played out against some of the largest climatic changes in the Earth's history," she said, including a major shift to drier and more variable conditions in Africa right about the time that the first tools appeared.

Harvard psychologist Marc Hauser underscored the cognitive gap between humans and other "smart species" such as chimps, elephants, and dolphins—a gap that he described as being "greater than that between those animals and worms." Recent findings in his own lab and others, Hauser said, show that nonhuman animals can solve specific problems in often sophisticated ways (for example, the nectar-mapping dances of honeybees and the ability of some bird species to hide food and retrieve it much later), but they cannot apply those talents to other situations. In contrast to such "laser-beam intelligence," Hauser said, humans have evolved "floodlight intelligence" capable of adapting one solution to many new problems. Even tool use by animals—such as chimpanzees using sticks to fish for termites—is "whoppingly different" from what humans do, Hauser insisted. He hopes that the manifold human differences summarized in his "humaniqueness hypothesis" will yield clues about how our species evolved.

–MICHAEL BALTER

Tracking and Tackling Deprivation's Toll

Children raised in poverty generally do worse in school and in their careers than do children from wealthier backgrounds. But why exactly does poverty affect them that way, and what can be done to break the cycle?

At the meeting, a University of Pennsylvania (Penn) psychologist described how the lack of environmental stimulation and parental nurturing in poor households might adversely affect language development and memory. Another researcher from the University of Oregon (UO), Eugene, explained how bolstering the child-rearing skills of low-income parents might help improve their

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children's mental abilities. "The more we learn about the pathways through which poverty affects kids, the more effective our interventions can be," says psychologist Jeanne Brooks-Gunn of Columbia University, who was not involved in either study.

Penn researchers have been following 110 African-American children born to mothers on welfare. Approximately half the mothers used cocaine and other drugs while pregnant. Visiting the children at home for an hour each at ages 4 and 8, the researchers rated the households on environmental stimulation (such as the child's access to books and musical instruments) and parental nurturance (emotional care such as praise). Between 2001 and 2004, when the children were between the ages of 11 and 13, the group gave them cognitive tests.

The researchers found that prenatal substance abuse had a negligible impact on either language or memory. But there was a strong positive correlation between environmental stimulation and language ability—that is, children raised in more stimulating environments did better at language tasks. More surprising, children who received better nurturing scored higher on memory tasks. Environmental stimulation seemed to have little or no effect on memory, and parental nurturance seemed to have no effect on the children's language abilities. "Our results show that poverty affects different neurocognitive systems in different ways," says Penn psychologist Martha Farah, lead author and presenter of the study, which is in press at *Developmental Science*.

In a more recent study not yet published, Farah and her colleagues analyzed magnetic resonance imaging scans of 47 children from the group when they were between the ages of 12 and 15. Children who had received less parental nurturing tended to have a larger hippocampus. Farah notes animal studies showing that rat pups that receive less grooming and licking from their mothers develop abnormal hippocampi and poor memory later in life. She speculates that babies who don't get enough nurturing and emotional warmth have difficulty coping with stress, which hurts brain development.

Hoping to blunt the impact of poverty, Jessica Fanning, a doctoral student at UO developed a program to teach parents ways to stimulate and nurture their toddlers. For 2 hours a week over 2 months, Fanning and colleagues taught 14 low-income parents enrolled in a Head Start program to reinforce positive behaviors and accomplishments in their children with specific praise, maintain consistent discipline at home, and use language in creative ways such as responding to something the child might say—such as, "Here goes the ship"—with a more descriptive sentence such as "The ship goes fast."

In tests conducted within a month after the course, the researchers found that the children whose parents had received the training showed gains on attentional and memory tasks; children of a control group did not. "The changes in parenting seem to have had a positive trickle-down effect on the children, at least in the short term," says psychologist Courtney Stevens, who worked on the study and presented the findings at the meeting.

–YUDHIJIT BHATTACHARJEE

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OCEAN CO_2 STUDIES LOOK BEYOND CORAL

One million tons of atmospheric carbon dioxide (CO_2) are dissolved into the oceans every hour, a process that helps maintain the Earth's delicate carbon balance. But CO_2 also makes seawater more acidic, and too much of it can wreak havoc on a marine species. Three sessions at the meeting described how marine scientists are trying to assess the effects of acidification.

The ocean's average pH worldwide, now roughly 8.4, has dropped about 0.1 since preindustrial times. Scientists estimate that it could fall another 0.4 by 2100 if carbon emissions continue on their current trajectories. That could put nearly two-thirds of known cold water corals into corrosive waters, Ulf Riebesell of the Leibniz Institute of Marine Sciences in Germany told one colloquium. But although the risks to corals are well-known (*Science*, 4 May 2007, p. 678), the effects on other marine life are just beginning to be characterized.

Gretchen Hofmann of the University of California (UC), Santa Barbara, reported that a one-two punch of lower pH and higher temperature can be fatal for the purple sea urchin, *Strongylocentrotus purpuratus*. Hofmann's lab studied urchins in tanks of seawater at normal pH and at the stronger acidity expected by 2100 under two possible atmospheres described by the Intergovernmental Panel on Climate Change. As the pH fell from 8.1 to 7.8, sea urchin larvae struggled to build their skeletons. DNA microarrays showed that genes involved in biomineralization raised their activity threefold. "The larva is desperately trying to make its body," Hofmann said. Unpublished results from the lab showed that larvae in the most acidic water grew "short and stumpy" skeletons. If the deformities carry over to adults, they could affect the valuable fishery for urchins, which are harvested for their eggs.

Threatened. Purple sea urchins are among many marine organisms likely to suffer as oceans acidify.

When Hofmann and colleagues warmed the acidified waters, mortality among the larvae skyrocketed. "Gretchen has the story dead on with the urchins," comments Andrew Baker of the University of Miami in Florida, who is studying the effects of temperature and acidity on corals. "Clearly, the effects are worse together than separate."

Hofmann and Victoria Fabry of California State University, San Marcos, are now studying how acidity and temperature affect the pteropod *Limacina helicina*, a peppercorn-sized swimming snail that forms a key part of the food web in the Southern Ocean. In their evolutionary history, Riebesell says, many species of pteropods "have never seen an ocean as acidic as the one they're going to see in the next 100 years."

Paleoclimate researchers are also beginning to study how high CO_2 levels might have impacted species in ancient seas. A team led by James Zachos of UC Santa Cruz is focusing on a 150,000-year period, 55 million years ago, when the amount of carbon released into the atmosphere—nearly 4 gigatons—is similar to the pulse researchers expect from current human emissions. Estimating ocean pH for this extreme event is tricky, Zachos said, because most of the standard indicators—calcium carbonate shells in sea-bottom cores—dissolved away. But he hopes computer modeling and isotope analysis of other shell samples will give his team a handle on the past—and possibly on our torrid future.

–ELI KINTISCH AND ERIK STOKSTAD