

and African fossils, and it therefore links them all as interbreeding members of the same wide-ranging species that gave rise to living humans.

"This fossil is a crucial piece of evidence showing that the splitting of *H. erectus* into two species is not justified," says co-author and paleoanthropologist Tim White of the University of California, Berkeley. "This African fossil is so similar to its Asian contemporaries that it's clear *H. erectus* was a truly successful, widespread species throughout the Old World." If White and his colleagues are right, there was a single species that spread from Africa to Europe to Asia 1 million years ago, rather than several different species alive at once.

But others say it is premature to write a death notice for *H. ergaster*. "I don't think it takes the wind out of the sails of *H. ergaster*," says Bernard Wood of George Washington University in Washington, D.C., who still thinks more than one species was alive 2 million to 1 million years ago. "I'm not at all convinced it is an intermediate," agrees Jeff Schwartz of the University of Pittsburgh. "To me, it says there was more diversity in these hominids."

The idea of *H. erectus* as the direct ancestor of living humans is a return to a view embraced by most anthropologists until the mid-1980s. That's when several scientists, including Wood, proposed that fossils found in Africa in the 1970s—including hominids that had lived as early as 1.8 million years ago on the shores of Lake Turkana in Kenya—differed from the classic specimens of *H. erectus* from Java, Indonesia, which appeared between 200,000 and 750,000 years later (*Science*, 2 March 2001, p. 1735). The Asian fossils, they argued, had generally more robust features and belonged to a separate species. That meant that *H. ergaster* was the human ancestor—and *H. erectus* was an Asian dead end, says Philip Rightmire of the State University of New York, Binghamton.

More than a decade of debate ensued. Then, in 1997, White's graduate student W. Henry Gilbert found a calvaria—a skull without a jaw—in the 1-million-year-old Daka member of the Bouri Formation of Ethiopia. Although gnawed by animals, it was well preserved. Most importantly, it shared features with both Asian and African fossils, including large, projecting brow ridges like those of the Asian *H. erectus*, says co-author Berhane Asfaw of the Rift Valley Service in Ethiopia.

The team compared the Bouri fossils with others from Africa, Europe, and Asia and used cladistic methods to rank 22 characters in the skulls, sorting them on an evolutionary tree. The researchers found that the Bouri skull, along with another skull from Olduvai in Tanzania, overlapped extensively with

Asian forms and later African fossils. "This clearly shows that the features previously considered to separate the Asian and African forms do not hold," says Asfaw. That evidence is persuasive for Rightmire and Eric Delson, a paleoanthropologist at Lehman College of the City University of New York. "So, *H. erectus* is still a pivotal species," says Delson. "This was the only game in town for a million years." But Wood and Schwartz continue to think there were other players on the scene, suggesting that the question is far from settled. "I don't think the issue will dry up and go away," predicts Rightmire.

—ANN GIBBONS

## NEUROSCIENCE

### The Good, the Bad, and The Anterior Cingulate

Making good decisions on the fly is a skill critical for many activities, from navigating freeway traffic to trading stocks on the Internet. Now researchers have linked a key component of this type of decision-making—the split-second evaluation of how well things are going—to a distinct pattern of brain activity.



**Winning big?** The anterior cingulate cortex can tell good news from bad.

On page 2279, psychologists William J. Gehring and Adrian R. Willoughby of the University of Michigan, Ann Arbor, report that electrical activity in the anterior cingulate cortex (ACC)—an area tucked into the crease between the two cerebral hemispheres—registers financial wins and losses as people play a gambling game. The authors believe that this brain activity may represent an immediate emotional reaction to the outcomes. The findings add a twist to theories on the role of the ACC and may provide insight into how decisions are swayed by emotion.

In recent years, studies by Gehring and others have suggested that the ACC plays a critical role in evaluating the outcomes of one's behaviors. For example, one theory holds that the ACC reacts when people make mistakes. But the new study suggests that the ACC may be doing something even more

**New Face at CNRS?** One of the most powerful posts in French science is about to be filled. Bernard Pau, currently director of the Institute of Biotechnology and Pharmacology in Montpellier, is the leading candidate for director of the life sciences department at CNRS, France's behemoth basic research agency, *Science* has learned. He would replace cell biologist Jacqueline Godet when she steps down in coming weeks.

Pau, 50, has an international reputation for developing diagnostic techniques for heart disease and other maladies. At CNRS, he would head a corps of 3285 researchers, nearly a third of the agency's total scientific cadre.

Researchers say that Pau's nomination will continue a trend, reinforced 2 years ago when medical researcher Geneviève Berger became CNRS director-general, of recruiting administrators ready to emphasize applied research. Says one French scientist: "CNRS is pushing very hard in that direction."

**Misconduct Defined** Marking the end of a long debate, the National Science Foundation (NSF) this week adopted a government-wide definition of what constitutes misconduct in science.

Two years ago, the Clinton Administration issued guidelines that defined scientific misconduct as fabrication, falsification, and plagiarism—"FFP" in Washington lingo (*Science*, 15 October 1999, p. 391). But the guidelines dropped a fourth term, "serious deviations," that NSF had argued was needed to cover misdeeds such as sexual harassment—but scientists argued was too open-ended. The final wording, echoed by the NSF rule published 18 March in the *Federal Register*, preserves the concept by requiring that FFP must rise to the level of a "serious departure" to be considered misconduct.

Other agencies are still incorporating the federal definition into their policies. The Department of Health and Human Services—the parent agency of the National Institutes of Health—expects to issue a rewrite of its 13-year-old rule later this year, according to staffers. And in the United Kingdom, the Wellcome Trust has proposed a misconduct definition far broader than FFP, including "deliberate, dangerous, or negligent deviations from accepted practices" (*Science*, 24 August 2001, p. 1411).

**Contributors:** Gretchen Vogel, David Malakoff, Michael Balter, Jocelyn Kaiser

fundamental: making subjective judgments about whether outcomes are good or bad, even before people are consciously aware of the results of what they've done.

"This starts to shed light on how subconscious processes can affect our decision-making and starts to provide a bit of the neural basis for that," says George Bush, a research psychiatrist at Harvard Medical School in Boston.

Gehring and Willoughby used electroencephalogram (EEG) electrodes to monitor the brain activity of people playing a gambling game. The gamblers chose one of two boxes that appeared on the screen of a computer monitor. One box indicated a 5-cent bet, the other a 25-cent bet. After a short delay, the boxes changed color. If the chosen box turned green, the amount bet was added to the person's stash; if it turned red, money was taken away. The color of the other box revealed how the players would have fared had they chosen differently. Win or lose, the EEG trace showed a distinctive dip arising from the medial frontal cortex—a response Gehring and Willoughby call the medial-frontal negativity (MFN). The MFN was more pronounced on loss trials—a difference that was evident within 200 to 300 milliseconds after the outcome of each bet was revealed. "This shows that the brain evaluates things very quickly," Gehring says.

The researchers don't see the MFN as simply a reflection of detecting mistakes, because the stronger response showed up even after correct choices, such as taking a 5-cent loss when the alternative was a 25-cent loss. Conversely, the MFN registered a win even when a choice led to the lesser of two gains. That might prompt people to reinterpret some of the studies linking the ACC to error detection, says experimental psychologist Don Tucker of the University of Oregon in Eugene: "You might even begin to think the reason this area responds to errors is because of their emotional significance."

Gehring and Willoughby also found that after losing a bet, people were more likely to bet big the next time around. Their MFN response to subsequent losses was enhanced, almost as if each successive loss was more painful. "It's the gambler's fallacy: If you lose money, you think you're due for a win," Gehring says. "Here's a brain system that's tuned the same way."

The findings fit well with studies of people with damage to the ACC and surrounding areas, says neurologist Antoine Bechara of the University of Iowa in Iowa City. These patients make poor decisions in lab tests and in everyday life, Bechara says, because they have difficulties judging the emotional significance of the results of their behaviors.

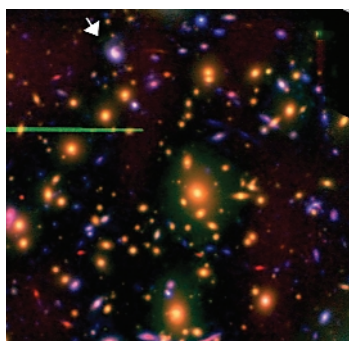
The study also represents a step toward the scientific study of human subjectivity,

according to experimental psychologist Brian Knutson of Stanford University: "A basic feature of subjectivity is deciding whether things are good or bad. For a long time, scientists have considered that unstudyable." But as the new study shows, in some cases the difference between good and bad can be caught in a dip on a graph. —GREG MILLER

## ASTROPHYSICS

## Distant Galaxy Heralds End of Dark Ages

After the big bang and the scorching fireball that followed it faded, the infant universe fell into what cosmologists call its Dark Ages. Light returned half a billion



**Bright spot.** The most distant known galaxy (arrow) appears to light up the universe's Dark Ages.

years later, when galaxies formed and the first stars ignited. Now a team of astronomers claims to have seen a galaxy—the most distant object ever detected—that pushes back the date when the Dark Ages ended and may imply that they were not so uniformly dark after all. "It's an important paper—as long as the results hold," says theoretical astrophysicist Abraham Loeb of Harvard University.

The Dark Ages began when the hot plasma of the fledgling universe cooled and recombined into neutral gas atoms, mainly hydrogen with some helium. This cold gas then slowly amalgamated into the first stars and galaxies. Only after those stars began cooking the opaque neutral hydrogen gas around them into a clear gas of ions did the Dark Ages lift and stars and galaxies become fully visible.

Any infant galaxy dating from this "epoch of reionization" at the end of the Dark Ages is likely to be at an immense distance and therefore very faint, at the limits of what existing telescopes can view. In an online paper ([www.arxiv.org/abs/astro-ph/0203091](http://www.arxiv.org/abs/astro-ph/0203091)) to be published in the 1 April issue of *Astrophysi-*

*cal Journal Letters*, Esther M. Hu of the University of Hawaii, Manoa, and colleagues describe how they found one such galaxy using a natural image intensifier: a gravitational lens. They trained the 10-meter Keck telescopes atop Mauna Kea, Hawaii, on a cluster of galaxies called Abell 370, about 6 billion light-years away. The gravity of this cluster acted as a lens, bending the light from a more distant galaxy behind it and brightening it by 4.5 times. "If it wasn't for the lens, you'd have to use a 30-meter [telescope] to get this data, which doesn't exist," says Hyron Spinrad, an astronomer at the University of California, Berkeley.

Hu's team looked for a red-glowing galaxy, the telltale signal of a star foundry whose ultraviolet emission has been stretched by redshift as it traversed the universe. The higher an object's redshift is, the farther the light has traveled and the earlier in the universe's history it left its source. The galaxy Hu and her team found has a redshift of 6.56, putting it about 15.5 billion light-years away, so we are seeing it as it was just 780 million years after the big bang. But seeing a star-forging galaxy that early on means that "the end of the Dark Ages lies earlier in time than people had previously thought," says Hu. "The thought had been that galaxies were put together somewhat later than this time," says Spinrad, so this new galaxy "is a little bit of a novelty."

Loeb is not entirely convinced. It's a "surprising claim," he says, not only because the galaxy formed so early,

but also because stars and quasars must have already cleared a path for its light by sweeping away the opaque neutral hydrogen. That scenario, Loeb says, sits uncomfortably alongside the findings of Xiaohui Fan of the Institute for Advanced Study in Princeton, New Jersey, who reported a quasar at a redshift of 6.28, last year's candidate for the "most distant" prize. Fan and his colleagues believe that missing wavelengths in their quasar's light indicated that there was still neutral hydrogen around at a redshift of 6.10,

