Humanity's Imprecision Vision

A volatile world may have forged minds that make a virtue of uncertainty

By BRUCE BOWER

In casual conversations, people eagerly trade examples of strange behaviors that seem to flow inevitably from human nature. Drivers nearly ram their vehicles into one another as they crane their necks to gape at fender benders; men all but trash the bathroom during brief visits and never notice (much less clean up) their mess; agonizingly off-key amateur warblers migrate to karaoke bars like swallows to Capistrano—sure, chalk it up to human nature.

Scientists take a different tack in pursuing the mechanisms that make minds tick. One influential school of thought, known as evolutionary psychology, views humans as having spent hundreds of thousands of years facing the relatively consistent demands of Stone Age life. As a result, even the most urbane folks now possess a passel of genetically programmed brain networks for solving the primary tasks of our hunter-gatherer ancestors—recognizing familiar faces, avoiding predators, finding a mate, and so on.

A separate but related theory holds that humans and other hominid species in our evolutionary family developed signature physical and behavioral traits—such as upright walking, stone-tool making, and big brains—beginning several million years ago to meet survival challenges as progressively cooler, drier conditions throughout the world prodded the expansion of African savannas.

The common assumption in such views—that specific conditions or challenges over the long haul molded brains and minds—bothers Richard Potts, an anthropologist at the Smithsonian Institution in Washington, D.C. From his perspective, like the casual generalizations about male bathroom users and karaoke crooners, it injects too great a sense of inevitability into how people behave. Instead, Potts exalts uncertainty as the way of the world and the instigator of human nature.

A growing body of data indicates that, over at least the past 6 million years, hominids and other creatures encountered repeated climatic fluctuations that remodeled landscapes, shifted the balance of available food and water, and altered population densities, according to Potts. In other words, the only thing certain about the world inhabited by our ancestors was its uncertainty.

Environmental instability added a new dimension to the evolutionary process of natural selection, Potts theorizes. He dubs this phenomenon "variability selection." Genes and behaviors that made possible resilient, innovative adaptations to new habitats assumed prominence. Animal species best able to scrounge out a living from whatever resources were available gained the upper hand (or hoof) over pickier creatures.

Homo sapiens and its direct ancestors, all scroungers to the core, have held high the banner of variability selection, Potts contends. Human nature thus reflects what might be called imprecision vision, a collection of traits for improvising survival on a fickle planet.

When faced with a crisis, modern hunter-gatherer populations may call on such aptitudes by pooling relevant information and using specific tactics for reaching collective decisions (SN: 11/18/95, p. 328).

"Our genetic blueprint enables our brains and societies to live creatively in an uncertain world," he remarks. "As the ability to use language is ingrained in us, so too is our sensitivity to novel conditions, without specifying the actual response [we should make]."

Potts has presented preliminary evidence in support of variability selection at several scientific meetings (SN: 11/25/95, p. 359), including the annual meeting of the American Association of Physical Anthropologists held last April in St. Louis. He has also written about the theory in a book titled *Humanity's Descent* (1996, New York: Avon Books) and in the Aug. 16, 1996 SCIENCE.

The idea that uncertain living conditions sparked the evolution of what makes us uniquely human comes at a time of intensive research into ancient hominid environments. A scientific consensus is emerging that human ancestors weathered more frequent climatic changes than has usually been assumed.

"I think there was great variability in climate and environment [during the Stone Age]," says anthropologist Peter Andrews of the British Museum in London, England. "But the ways in which those conditions affected hominid evolution are poorly understood."

Potts maintains that clues exist, and they finger variability selection as a prime influence on hominid evolution. Independent studies of pollen and other wind-blown material in ancient soil dug out of the ocean floor indicate that global climate shifts increased in frequency between 5 million and 3 million years ago. It's no coincidence, in the Smithsonian scientist's view, that the earliest hominids evolved a two-legged gait that allowed them to exploit resources in both wooded areas and open grasslands.

Soil and fossil studies directed by Potts at western Kenya's Kanam Formation also yield evidence of a number of environmental fluctuations between roughly 6 million and 5 million years ago, the time at which the first hominids are thought to have appeared.

Pronounced shifts in Africa to a colder, drier climate occurred at least three times—about 2.8 million, 1.7 million, and 1 million years ago—according to analyses of dust layers in ocean-floor sediment conducted by paleoclimatologist Peter B. deMenocal of the Lamont-Doherty Earth Observatory in Palisades, N.Y. Moreover, the period from 2.8 million to 1 million years ago featured alternations between ice-age and warmer conditions every 40,000 years or so, deMenocal says.

At 1 million years ago, ice ages grew more intense and each cycle of colder and warmer weather lasted approximately 100,000 years, he adds.

Hominids had to react nimbly each time the environmental rug was pulled out from under their feet, Potts asserts. Such responsiveness took the form of increases in relative brain size, widespread manufacturing of stone tools appropriate for many tasks, and a penchant for journeying to different geographic regions, Potts asserts.

Ancient hominid sites also contain traces of the behaviors that arose in the face of environmental change, the Smithsonian scientist contends. Stone sources and patterns of tool-making debris vary in conjunction with landscape changes at several sites: locations in northern Kenya and southern Ethiopia, from 2.3 million to 1.6 million years ago; Tanzania's Olduvai Gorge, from 1.8 million to 1.2 million years ago; and southern Kenya's Olorgesailie region, from 1.2 million to 500,000 years ago.

Variability selection appears to have swayed the fates of many African mammals, not just hominids, according to Potts. For instance, a handful of formerly dominant plant-eating animals in southern Kenya, including some elephant species, died out between 800,000 and 400,000 years ago; all of those creatures had traits consistent with a highly specialized diet. Evolutionary relatives of those extinct species that had smaller bodies and teeth, a sign of more generalized grazing, survived the same environmental upheavals, Potts says.

This species sorting process applied to hominids as well, in his view. Consider *Paranthropus*, a large-jawed, upright creature that lived at the same time as early *Homo*. *Paranthropus* mainly ate plants and nuts, unlike its omnivorous *Homo* brethren, and became extinct around 1 million years ago.

The same fate later befell Neandertals, apparently for much the same reasons. Neandertals exhibited physical traits tailored to extremely cold conditions and traveled in a far more limited geographical range than *Homo erectus* and *Homo sapiens*.

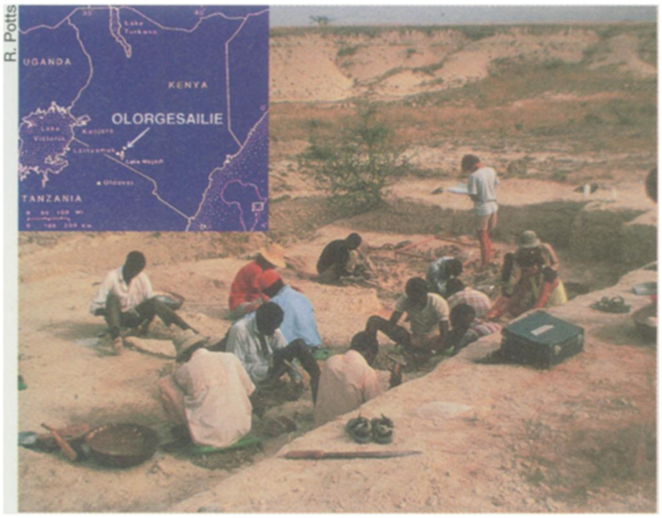
Further research on variability selection needs to examine the interaction of factors such as the magnitude of changes in landscape, the length of intervals between climatic fluctuations, and the number of generations of a particular species exposed to the same environment, Potts adds.

Several scientists see promise in Potts' theory. For instance, anthropologist Steven R. Leigh of the University of Illinois at Urbana-Champaign suspects that the pressure of coping with an ever-changing world forged the evolution of the prolonged human growth period. At April's physical anthropology meeting, Leigh presented a comparative study of 35 living primate species. He identified in humans the longest stretch of individual brain development, lasting throughout the first 6 years of life, and a significant spurt in physical growth around age 10. Taking into account body size, people develop over a more extended period than any other primate.

This developmental pattern is consistent with a need for extensive early learning to coordinate visual and motor systems in the brain with upright walking and to inculcate fundamental social skills, such as speaking, Leigh notes.

A few years' delay between a halt in brain growth and a spurt in body size may give kids a chance to soak up cultural knowledge that aids the transition into adulthood, he suggests. This information might include guidelines for locating food sources and participating in social tasks.

Variability selection may have influenced mammals long before hominids strode onto the scene, asserts psychobiologist Lori Marino of Emory University in Atlanta. Evidence of large global temperature fluctuations and environmental disturbances extends from around 40 million to 10 million years ago, she notes. During that period, a number of ancestral species of cetaceans—dolphins, porpoises, and whales—died out; surviving cetaceans, and dolphins in particular, evolved the largest brains relative to body size of any animal save modern humans, according to studies conducted by Marino.



R. Potts

Excavations at Olorgesailie in Kenya (see map, inset) have yielded clues to ancient climate shifts.

"Variability selection may explain brain-size increases in dolphins as well as people," she says. "This is a possibility I want to explore."

Geologist Elisabeth S. Vrba of Yale University also supports Potts' position but does not rank it as a marked departure from her prior views.

For more than a decade, Vrba has championed what she calls the turnover-pulse hypothesis of evolutionary change. In essence, this theory holds that new species emerge and old species die out only when their physical surroundings undergo substantial changes. The timing of speciations and extinctions differs for animals living in the same region that have adapted to contrasting habitats, Vrba states.

For example, lineages of pigs, monkeys, and giraffes propagated prior to 3 million years ago in Africa, when the continent was warm, wet, and wooded. A shift to cooler savanna conditions between 2.7 million and 2.4 million years ago led to the emergence of animals such as antelopes and rodents.

Changes in the intervals between ice ages at 2.8 million and 1 million years ago, as documented by deMenocal, coincided with the times at which African antelopes and related creatures evolved into the greatest diversity of species, Vrba says. Hominid evolution may have taken a comparable course, the Yale scientist proposes.

A process such as variability selection could have contributed to the preservation of lineages of habitat generalists, who at climatic junctures would have branched off into new species, she holds.

Others familiar with Potts' argument find it less appealing.

Scientists investigating Ethiopia's Hadar Formation acknowledge that *Australopithecus afarensis*—a hominid species that includes the partial skeleton of the individual known as Lucy—existed in a surprisingly diverse array of environments from 4 million to 3 million years ago, at which point it died out fairly suddenly.

"*Afarensis* apparently adapted well to variable circumstances and went extinct anyway," says geologist and Hadar investigator Kaye E. Reed of the Institute of Human Origins in Berkeley, Calif. "I'm not sure that this fits with Potts' theory."

Whether genetic processes are capable of carrying out variability selection is also unclear, asserts geneticist James M. Cheverud of Washington University School of Medicine in St. Louis. Researchers know that, thanks to certain genes, the shapes and behaviors of some plants and animals diversify markedly within a single generation if they are transplanted to a new habitat. But there's no reason to expect that DNA underwrites such flexibility in species that encounter a renovated terrain every few thousand generations, Cheverud contends.

Such a possibility nonetheless deserves close scrutiny in further studies, comments geologist Craig S. Feibel of Rutgers University in New Brunswick, N.J.

"Climatic fluctuations are the most distinctive features of the global environment over the past 5 million years," Feibel asserts. "We need to look more carefully at what was happening to the places that hominids actually lived in." □