anandamide incentivizes survival

Homo sapiens are "wired to run"

By O'S News Service

Running and other forms of aerobic activity increase production of anandamide —the neurotransmitter that THC imitates— in the brains of certain mammals, including people. The authors of a study published this spring in the *Journal Of Experimental Biology* suggest that the brain's reward system provided a neurobiological incentive for our remote ancestors to run for long distances. The incentive promoted survival and thus helped shape the evolution of the human body.

"Cursorial" refers to animals that run long distances —wolves, horses, pronghorn, etc.

The *JEB* paper by David Raichlen of the University of Arizona, Gregory Gerdemann of Eckerd College, and colleagues is called "Wired to run: exercise-induced endocannabinoid signaling in humans and cursorial mammals with implications for

the 'runner's high."' Endocannabinoid signalling in the hypothalamus, the nucleus accumbens and other areas of the brain associated with reward is at least partly responsible for the "high" reported by many athletes during and after a vigorous workout.

Previous studies at UC Irvine had provided some unexpected support for this idea, using mice that had been bred over many generations to engage in very high levels of wheel-running exercise. Mice are not naturally "cursorial," but these specially-bred mice would cover several kilometers every night. When the Irvine researchers used the drug Rimonabant to block their endocannabinoid systems, the mice reverted to more typical, low-exercise behavior.

These findings suggested that artificial selection through a laboratory breeding program could lead to the evolution of running behaviors by specifically boosting genes of the brain's endocannabinoid system that get blocked by Rimonabant.

Raichlen and Gerdeman got a grant from the National Science Foundation to study whether a similar phenomenon occurs in dogs (running animals), ferrets (sedentary animals), and homo sapiens (running for countless eons as we evolved, but increasingly sedentary in recent generations). Did natural selection also work through the genes of the endocannabinoid system to promote the evolution of running behaviors? Are human beings "wired to run?"

Their team took blood samples from the test subjects before and after vigorous workouts on a treadmill. They determined that anandamide levels rose significantly in people and dogs, but not in ferrets. In humans, the concentrations of anandamide in blood were tightly correlated to subjects' improvement on a psychological questionnaire assessing positive emotional well-being, thus supporting the possible causality between cannabinoid-receptor activation and the "runner's high" (broadly interpreted as a state of elevated mood).

On the other hand, non-strenuous activity such as walking did not raise anandamide levels at all.

"This study provides the first evidence that inter-specific variation in neurotransmitter signaling may explain differences in locomotor behavior among mammals," the authors conclude. "Thus, a neurobiological reward for endurance exercise may explain why humans and other cursorial mammals habitually engage in aerobic exercise despite the higher associated energy costs and injury risks, and why non-cursorial mammals avoid such locomotor behaviors."

The authors note that the same system that might have motivated distance running would also mitigate the pain and damage involved. Anthropologists have long wondered, Gerdeman adds in an email, "why early hominids, for whom running would have been much more difficult based on their skeletal anatomy, would have engaged in behaviors that are energetically taxing and increase the chance of injury in a predator-rich world?" He proposes an answer: "The endocannabinoid system as an engine driving evolutionary change. Analgesia, anti-inflammatory, enhancing bone density —it all fits this model."

Add to the Glossary: "Cursorial"

The word "cursorial" is related to "course," meaning as a verb, "to run through" (as in, for example, "a river courses through the valley"), and as a noun, the ground covered (as in a race course).

It's ironic that a word long used by anthropologists (and nobody else) to describe animals capable of running long distances, now evokes the image of an animal sitting on its butt while manipulating a little item on the computer screen. I had just encountered "cursorial" in a piece about pronghorn *(Antilocapra Americana)*.

According to pop-sci writer Rob Dunn, pronghorn "at medium distances… may well be the fastest animal ever to have lived." Dunn's book "The Wild Life Of Our Bodies," describes some intriguing but unproven hypotheses about how interacting species have co-evolved. His opening chapter discusses the possibility that the wipe-out of our intestinal parasites by modern hygiene and antibiotics has led to a rising incidence of Crohn's disease (because under-employed digestive juices attack the lining of the gut).

Dunn continues: "There was precedent for the idea that one species, such as a human, might miss another species, even one such as an intestinal worm that had done it harm. The precedent involved pronghorn… small, goat-sized animals. Though they are sometimes called antelope, they are not precisely antelope and not precisely deer either. They are unique. Their branch on the tree of life has been separate from other branches for much longer than humans have been separate from other primates."

There are some 10 million pronghorn left on the western grasslands of North America. "Once there were many kinds of' pronghorn but now there is just a single lithe species," Dunn recounts. "The pronghorn's body is tan on the back and white on the belly. It has a dark black nose and dark black two-pronged antlers. Compared to elk, to moose, or even to true antelope, pronghorns are dervishes —light and muscular. A pronghorn can run a hundred kilometers an hour… Even after running fast and long, they can run faster and longer."

"As recently as 10,000 years ago, just as cows were beginning to be domesticated in Asia, the pronghorn lived on the plains with the gray wolf, black bear, grizzly bear, and coyote, but also with other large predators. When humans first arrived in the Americas, they found the pronghorn and alongside them a much greater variety of other herbivores, but, in addition, an even greater variety of predators. The American grasslands were more wild and ferocious than the African plains. The predators that the earliest immigrants to America found as they colonized the continent fourteen-or-more thousand years ago were bigger, badder, and faster than anything we know today There were plundering dogs (*Borophagus* spp.) short-legged dogs (*Protocyin* spp.), dire wolves (*Canus dirus*), giant cheetahs, giant cave lions (*Panthera atrox),* several kinds of sabre-toothed cats, giant short-faced bears (*Arctodus simus*), and other toothy monsters, many of them fast. The cave lion grew to twelve feet in length. The saber-toothed cat could weigh 1,000 pounds and the giant short-faced bear as much as 2,500 pounds. Most relevan to the story of the pronghorn, though, was the American cheetah *(Miracinonyx trumani),* a big, long, fast cat built to chase and catch at high speeds. Analogies with modern African cheetahs suggest that the American cheetah would have loved to eat pronghorn the way African cheetahs love antelope…

The investigators' underlying question: "why early hominids, for whom running would have been much more difficult based on their skeletal anatomy, would have engaged in behaviors that are energetically taxing and increase the chance of injury in a predator-rich world?"

Pronghorn are not antelope, deer or sheep but a species unto themselves. Photo by Mark Gocke

The ferret is a non-cursorial animal that sleeps 14-18 hours and is active at dawn and dusk. Ferrets were domesticated to hunt rabbits.

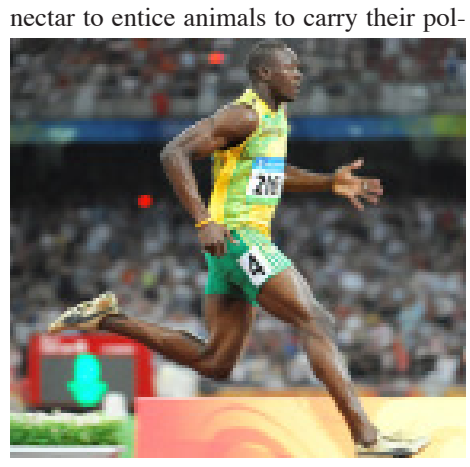
"The pronghorn once had something to flee. American cheetahs evolved to be faster to pursue faster pronghorn and pronghorn evolved to be even faster in return. Then humans arrived in the Americas and, one way or another, killed off sixty large mammal species, including the cheetah, but also lions, mammoths, mastodons, and even camels. The extinction of these great beasts and, in particular, of the American cheetah, left the pronghorn anachronistically and irrelevantly fast."

The pronghorn had evolved to flee predators —even the shape of the uterus has been designed for slenderness. But now that the predators are gone, Dunn speculates, traits related to speed "may be costly… The individuals that run the fastest may die younger, exhausted from fleeing ghosts but unable to slow down."

On the other hand, homo sapiens are way more lethal than the dire wolf and the atrocious panther.)

The Pronghorn Principle

"The pronghorn principle," Dunn generalizes, "has two elements: First, all species have physical characteristics and genes that relate to the ways in which they interact with other species. Second, when those other species are removed, such features become anachronistic or worse. Plants have evolved toxins to defend their leaves, nectar to entice animals to carry their pollen, and fruits to attract other animals to carry their seeds. Animals, in turn, evolved long tongues to reach nectar or better senses of smell to detect fruit. carnivores have long, sharp teeth to kill their prey. Intestinal parasites have appendages that mirror, in their contours, the guts of their hosts, to hang on.



"Pick any organism on Earth and as much of its biology is defined by how it interacts with other species as is influenced by the basics of living, eating, breathing, and mating. Interactions among species (what ecologists call interspecific interactions) are part of the tangled bank to which Darwin referred… The consequences of removing the species our bodies evolved to interact with, be they predators (as in the case of the cheetah), mutualists like the animals that once dispersed the giant American fruits [papayas, avocados, guava, charimoya et al] or even parasites and disease."