ADAPTATION

Disease for Darwinism

More kids, less cancer: Huntington's may confer survival benefits BY MELINDA WENNER

Over the past 35 years, scientists have made several curious discoveries about Huntington's disease. First, individuals with the neurological disorder are less likely than others to suffer from cancer; second, they tend to have more children than average—about 1.24 children for every one child born to unaffected siblings. Although no one yet knows what is behind these seemingly unconnected findings, a group at Tufts University has proposed that they are linked—and that one of the proteins implicated in Huntington's may, ironically, provide patients with subtle health benefits.

Huntington's destroys neurons in the neostriatum, a region of the brain associated with motor control and cognition. As a result, patients have difficulty controlling their movements and experience a range of cognitive and emotional problems. The disease is caused by a mutation that substantially lengthens a gene known as *huntingtin,* increasing the number of repeated sequences it contains. The length of the gene varies within the general population and becomes problematic only when it exceeds a certain extent. The gene's length also affects the severity of symptoms.

Although scientists do not know exactly why the mutation causes neurons to die, studies suggest that a protein called p53 plays a role. The protein has many diverse functions: it helps to regulate when cells divide and die and when new blood vessels form. In Huntington's, levels of p53 in the blood are higher than normal; p53 has also been shown to bind to the protein created from the mutant *huntingtin* gene. In addition, animals with the mutation seem to develop the disease only if their bodies can make p53. "The link between p53 and Huntington's disease is very important," says Akira Sawa, director of the Program in Molecular Psychiatry at Johns Hopkins University.

NATURALLY SELECTED? **Mutation for Huntington's disease may be adaptive.**

Given the diversity of p53's functions, Philip Starks, a biologist at Tufts, and two of his students, Ben Eskenazi and Noah Wilson-Rich, recently speculated that increased p53 could be responsible for the disease's link to reduced cancer incidence and increased family size. "When Ben located published information on elevated p53 and relatively low cancer levels in Huntington's disease–positive individuals, it was a minor eureka moment for us," Starks explains. Because p53 regulates cell division, the protein helps to ward off cancer, so it is not ridiculous to think that higher levels might lower cancer risk, Starks says.

P53 also appears to play a part in immunity, leading Starks and his students to wonder whether Huntington's patients might also have heightened immune function during their childbearing years—a characteristic that could explain their increased family size. "We expect that the immune system should be positively related with reproductive success," explains Kenneth Fedorka, an evolutionary biologist at the University of Central Florida. Fedorka emphasizes, however, that the relation between immunity and reproductive success is complex; more research would be needed to tease out whether p53-triggered immune changes would actually lead patients to have more children. In any case, that Huntington's patients have more kids may explain why some studies suggest that the prevalence of the disease is slowly increasing. (Others maintain that doctors are simply making better diagnoses.)

Starks and his students believe that Huntington's is an example of antagonistic pleiotropy—a situation in which a gene has opposing effects on an organism. "The same pathological protein aggregates that debilitate Huntington's sufferers later in life may actually make them stronger and [more] reproductively successful in their prime," Eskenazi says. Such a mutation can survive, generation after generation, assuming that the deleterious effects do not appear until after childbearing years.

But that is a big assumption. Many people acquire Huntington's before or during their reproductive years, says Jane Paulsen, director of the Huntington's Disease Center at the University of Iowa. Although the average age of diagnosis is 39, it ranges from age two to 82, depending on mutation severity. "You're talking about such a small subsample of the population that really would have their presymptomatic years be commensurate with their reproductive years," Paulsen says.

And even if the disease does not fully develop until later in life, people with the gene often experience psychological changes such as depression and cognitive deficits many years before diagnosis, says David Rubinsztein, a molecular neurogeneticist at the University of Cambridge; these changes might influence their decision or ability to have children. "I'm not entirely convinced that patients who have Huntington's disease are necessarily more

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fecund than those who don't," he says.

Starks points out that his model, published in the November 13, 2007, *Medical Hypotheses,* is indeed speculative. He hopes, however, his ideas linking increased p53 to reduced cancer risk and increased family size will spark further studies. Paulsen agrees that even if the model is wrong, it is certain to raise interest and is a good thing. "What does provocation do to science?" Paulsen asks. Ideally, "it makes it better. That's what hypotheses are for."

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COMMUNICATIONS

Aerial Stealth

Plasma antennas disappear when shut off BY STEVEN ASHLEY

ANTENNA VANISHES from radar when the electricity fed to a plasma-filled tube is cut off.

HALEAKALA RESEARCH AND DEVELOPMENT, INC., COURTESY OF THEODORE ANDERSON

Radar uses radio waves to enable aircraft, ships and ground stations to see far into their surroundings even at night and in bad weather. The metal antennas behind those waves also strongly reflect radar, making them highly visible to others—a deadly disadvantage during wartime. A new class of nonmetallic radio antennas can become invisible to radar—by ceasing to reflect radio waves—when deactivated. This innovation, called plasma antenna technology, is based on energizing gases in sealed tubes to form clouds of freely moving electrons and charged ions.

Although the notion of the plasma antenna has been knocked around in labs for decades, Ted Anderson, president of Haleakala Research and Development—a small firm in Brookfield, Mass.—and physicist Igor Alexeff of the University of Tennessee–Knoxville have recently revived interest in the concept. Their research reopens the possibility of compact and jamming-resistant antennas that use modest amounts of power, generate little noise, do not interfere with other antennas and can be easily tuned to many frequencies.

When a radio-frequency electric pulse is applied to one end of such a tube (Anderson and Alexeff use fluorescent lamps), the energy from the pulse ionizes the gas inside to produce a plasma. "The high electron density within this plasma makes it an excellent conductor of electricity, just like metal," Anderson says. When in an energized state, the enclosed plasma can readily radiate, absorb or reflect electromagnetic waves. Altering the plasma density by adjusting the applied power changes the radio frequencies it broadcasts and picks up. In addition, antennas tuned to the right plasma densities can be sensitive to lower radio frequencies while remaining unresponsive to the higher frequencies used by most radars. But unlike metal, once the voltage is switched off, the plasma rapidly returns to a neutral gas, and the antenna, in effect, disappears.

This vanishing act could have several applications, Alexeff reports. Defense contractor Lockheed Martin will soon flight-test a plasma antenna (encased in a tough, nonconducting polymer) that is designed to be immune from detection by radar even as it transmits and receives low-frequency radio waves. The U.S. Air Force, meanwhile, hopes that the technology will be able to shield satellite electronics from powerful jamming signals that might be beamed from enemy missiles. And the U.S. Army is supporting research on steerable plasma antenna arrays in which a radar transmitter-receiver is ringed by plasma antenna reflectors. "When one of the antennas is deactivated, microwave signals radiating from the center pass through the open window in a highly directional beam," Alexeff says. Conversely, the same apparatus can act as a directional receiver to precisely locate radio emitters.

Not all researchers familiar with the technology are so sanguine about its prospects, however. More than a decade ago the U.S. Navy explored plasma antenna technology, recalls Wally Manheimer, a plasma physicist at the Naval Research Laboratory. It hoped that plasmas could form the basis of a compact and stealthy upgrade to the metallic phased-array radars used today on the U.S. Navy's Aegis cruisers and other vessels. Microwave beams from these arrays of antenna elements can be steered electronically toward targets. Naval researchers, Manheimer recounts, attempted to use plasma antenna technology aimed by magnetic fields to create a more precise "agile mirror" array. To function well, the resulting beams needed to be steered in two dimensions; unfortunately, the scientists could move them in only one orientation, so the U.S. Navy canceled the program.

Signal Clouds

Having taken heavy casualties, your reconnaissance team is cut off deep within enemy territory. You need extraction fast, but the surrounding mountains are blocking your communications. What do you do? Plasma antenna researchers may have a solution. Several have patented a concept by which antennas relying on plasma gas could transmit and receive signals when more conventional communications links fail. Essentially, explosive charges would propel a jet of plasma high into the air, and the resulting cloud of ionized gas would then strongly propagate electromagnetic signals from a special radio set.