Nature vs. Nurture Revisited

By Kevin DaviesPosted 04.17.01NOVA

The most shocking surprise that emerged from the full sequence of the human genome earlier this year is that we are the proud owners of a paltry 30,000 genes—barely twice the number of a fruit fly.

After a decade of hype surrounding the Human Genome Project, punctuated at regular intervals by gaudy headlines proclaiming the discovery of genes for killer diseases and complex traits, this unexpected result led some journalists to a stunning conclusion. The seesaw struggle between our genes (nature) and the environment (nurture) had swung sharply in favor of nurture.

The news that shocked the world: We have only about twice as many genes as your average fruit fly. Enlarge

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"We simply do not have enough genes for this idea of biological determinism to be right," asserted Craig Venter, president of Celera Genomics, one of the two teams that cracked the human genome last February.

"HALFTIME FOR GENETICS"

Indeed, Venter has wasted little time in playing down the importance of the genes he has catalogued. He cites the example of colon cancer, which is often associated with a defective "colon cancer" gene. Even though some patients carry this mutated gene in every cell, the cancer only occurs in the colon because it is triggered by toxins secreted by bacteria in the gut. Cancer, argues Venter, is an environmental disease. Strong support for this viewpoint appeared last year in the New England Journal of Medicine. Researchers in Scandinavia studying 45,000 pairs of twins concluded that cancer is largely caused by environmental rather than inherited factors, a surprising conclusion after a decade of headlines touting the discovery of the "breast cancer gene," the "colon cancer gene," and many more.

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But can the role of heredity really be dismissed so easily? In fact, the meager tally of human genes is not the affront to our species' self-esteem as it first appears. More genes will undoubtedly come to light over the next year or two as researchers stitch together the final pieces of the human genome. More importantly, human genes give rise to many related proteins, each potentially capable of performing a different function in our bodies. A conservative estimate is that 30,000 human genes produce ten times as many proteins in the human

body, and figuring out what these proteins do will be a challenge for a century or more. "This is just halftime for genetics," says Eric Lander, a leading member of the public genome project, alluding to decades of work ahead to unravel the function of all the proteins in the body.

Notwithstanding the valuable discovery of BRCA1, the "breast cancer gene," researchers insist the causes of cancer lie more with nurture than with nature.
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OUR SNIPS, OURSELVES

The key to ultimately defining the respective roles of genes and environment lies with "snips"—genespeak for the sites littered throughout our DNA that frequently vary between unrelated people. About three million differences exist in the genomes of any two unrelated people, but of these only about 10,000 or so are likely to have any functional consequences.

Scientists have already linked some of these specific DNA variations with increased risk of common diseases and conditions, including cancer, asthma, diabetes, hypertension, and Alzheimer's. Other snips affect the way people react toward certain drugs. Everyone carries between five and 50 genetic glitches that might predispose that person to a serious physical or mental illness. Identifying these flaws will enable doctors to predict individual disease risks, recommend suitable lifestyle regimens, and prescribe the safest and most effective drugs.

Fingering the flaws in their patients' genetic code will enable doctors of the near future to better prepare those individuals with high risk for certain diseases.
Enlarge
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But divining DNA variations to uncover health risks will increasingly threaten our ability to land and hold jobs, secure insurance, and keep our personal genetic profiles private. "We're all ultimately unemployable and uninsurable," warns New York Representative Louise Slaughter, co-author of a new genetic privacy bill in Congress, "even the president of a health insurance company!" Without laws prohibiting genetic discrimination, she says, society may soon begin penalizing people with "bad" genes. Even though 22 states have passed genetic privacy laws, Slaughter believes the confidentiality of your genetic code should not depend on your zip code. Francis Collins, director of the public genome project, says "We don't get to pick our genes, so our genes shouldn't be used against us."

BECOMING US

While the next few years will undoubtedly see major progress in rooting out

genetic factors that influence our likelihood of contracting common diseases, what about the role that genes play in shaping human behavior and personality? Despite the media hype following recent claims for the discovery of genes controlling addiction, shyness, thrill seeking, and most controversially, sexual orientation, in reality these genes have provided little more than tantalizing clues to these traits. No one has identified (or even claimed to have identified) a "gay gene," and the first few genes associated with other personality traits appear to have only a minor effect. However, with the full genome sequence now accessible over the Internet, scientists hope to pin down many more genes that code for various aspects of human behavior.

Ever since the early days of genome sequencing, scientists have searched for elusive genetic clues to human behavior. Enlarge
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Yet is it realistic to believe that single genes can have a major impact on behavior? Much attention is currently focused on the genes that code for proteins involved in the transmission of electrical signals in the brain. If drugs such as the antidepressant Prozac work by altering the activity of neurotransmitters (brain chemicals that convey messages between nerve cells), it is plausible that inherited variations in the proteins that produce those chemicals could exert a dramatic effect on an individual's mood and temperament. But even the most diehard geneticists acknowledge that the environment plays a major role in shaping our behavior, temperament, and intelligence.
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With so much attention on explaining behavior in terms either of nature or nurture, scientists at the University of California, San Francisco recently described a fascinating example of how heredity and environment can interact. Perfect pitch is the ability to recognize the absolute pitch of a musical tone without any reference note. People with perfect pitch often have relatives with the same gift, and recent studies show that perfect pitch is a highly inherited trait, quite possibly the result of a single gene.
But the studies also demonstrate a requirement for early musical training (before age six) in order to manifest perfect pitch. Time will tell whether there is a "perfect pitch" gene, but it seems reasonable to think that many personality and behavioral traits will not be exclusively the province of nature or nurture, but rather an inextricable combination of both.

Highly sophisticated technology, like this gene-sequencing machine at Celera Genomics, is helping to spur advances in molecular medicine. Enlarge
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GENE GENIES

Regardless of how many genes are ultimately linked to disease risk and human behavior, one thing is certain: The technology to detect and possibly select genes for future generations is rapidly improving.

In the near future, DNA chips will exist that can detect thousands of the most significant variations in our DNA. A decade or two from now, parents of newborn babies may leave the hospital with a full genome analysis of their offspring that reveals hundreds of disease-related risk factors and susceptibilities. And doctors will be able to screen for more and more traits using in vitro fertilization techniques such as preimplantation genetic diagnosis (PGD). Doctors demonstrated the power of PGD last year when the Jack and Lisa Nash family of Englewood, Colorado selected an embryo that not only lacked the gene for a fatal genetic disease, Fanconi anemia, but also provided a bone marrow match for their dying daughter.

Thus, while Venter is undoubtedly right when he proclaims that "humans are not hardwired," increasingly we will be able to fiddle with our genetic wiring such that, in the complex balance achieved by nature and nurture, nature gets a little boost.

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Sources