SCIENCE

Genetic Intelligence Tests Are Next to Worthless

And not just because one said I was below average.

CARL ZIMMER MAY 29, 2018

KARIM KADIM / AP

In 2016, I got my genome sequenced while I was working on a book about heredity. Some scientists kindly pointed out some of the interesting features of my genetic landscape. And then they showed me how to navigate the data on my own. Ever since, I've been a genomic wayfarer. Whenever I come across some new insight into the links between our genes and our lives, I check my own DNA. One day I'm inspecting a mutation that raises my risk of skin cancer. The next I'm discovering I have a variant for smooth teeth.

I often consult a website called DNA.Land, run by a team of scientists affiliated with the New York Genome Center who use it to collect genetic data from volunteers for scientific research. Over 100,000 people have signed up so far (the service is free, and the researchers don't sell the information to third parties). As a token of appreciation, the researchers write programs to analyze their volunteers' DNA, generating new reports based on the latest studies.

On a recent visit to DNA.Land, I scanned down the list of traits they offered to tell me about. I stopped at *intelligence*.

I took a breath before I clicked.

Intelligence, after all, is different from the smoothness of your teeth or your risk of skin cancer. People have fought over the very meaning of the word for over a century. In the early 1900s, some psychologists claimed that intelligence was the mental power underlying many different tasks we carry out, from solving problems to remembering facts. And they developed ways to measure it with a number, just as a doctor might give a number for your blood pressure or body temperature.

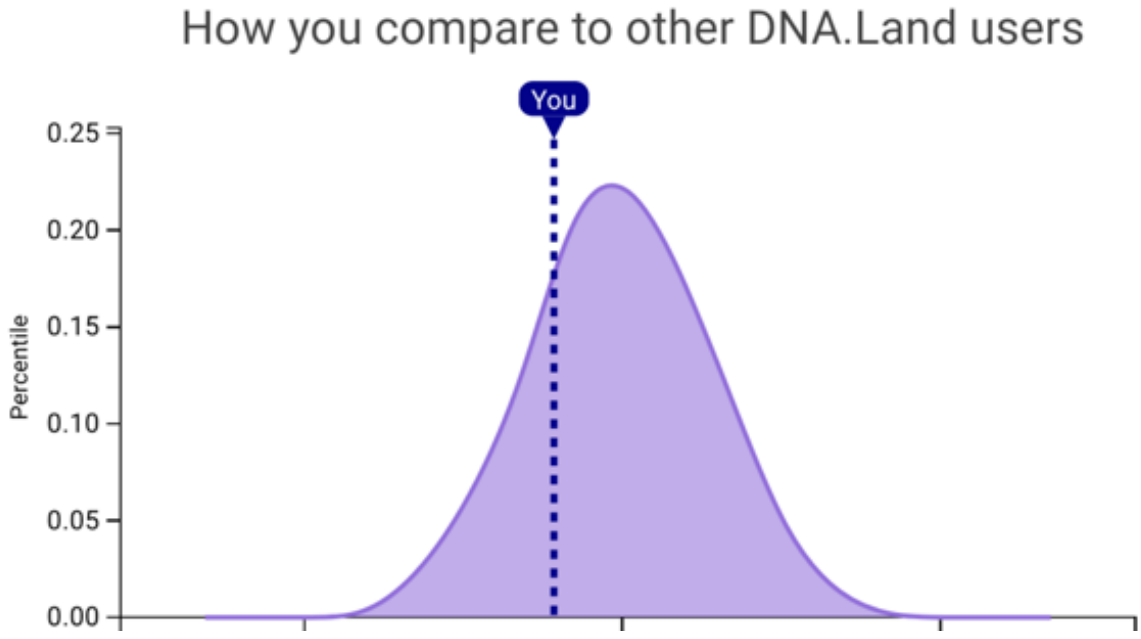
But critics argued that the things we associate with intelligence are too complex and ambiguous to pin down in such a simplistic way. Meanwhile, eugenicists used the emerging concept of intelligence in their campaign to recast society. They argued that people's different intelligence test scores were largely due to differences in their genes, and so for the good of society, more intelligent people should have more children and less intelligent ones should not.

In the United States, eugenicists successfully campaigned for women deemed unfit to be sterilized. They lent their support to laws banning marriages between blacks and whites. They helped block immigration

from Italy, Russia, and other countries where people were judged to have inferior intelligence. Nazi scientists imitated the American eugenicists and went further, using intelligence tests in hereditary health courts to decide who lived and died.

Yet intelligence, as a scientific concept, endured. The scores that people get on intelligence tests tend to stay similar from childhood to old age. Intelligence test scores are correlated with many other things, from people's reaction times answering simple questions to their odds of surviving into their 70s. What precisely it is that intelligence tests measure—the efficiency of the brain's wiring, perhaps—is not yet clear. But they measure something significant. And in just the past couple years, scientists have started to find some of the genes that play a role in how we do on these tests.

I took a breath and clicked on the link. I was swiftly sent to a new page, entitled "General Intelligence Trait Prediction Report for Carl Zimmer." And on that page, here's what I saw:



DNA.LAND

The bell curve was surrounded by notes, disclaimers, and symbols.

But my eye stayed locked on that lavender hill—especially on that personalized marker that located me on the low side of the scale.

What was I to make of this? For some reason, DNA.Land's prediction felt more profound than if I had taken an actual IQ test. It didn't depend on whether I could recall some random string of words at a particular moment. Instead, I was looking inside myself, at the immutable genes that shaped me from before birth.

When I sent the curve to my mother, she emailed back, "Those results can't be right! Simply cannot!"

I called up Yaniv Erlich, the scientist who wrote the intelligence program, to ask him about his prediction. Erlich, I should point out, majored in computational neuroscience, got a Ph.D. in genetics, became an associate professor at Columbia, and is on leave from teaching to serve as the chief science officer at the DNA-testing company MyHeritage. I imagine Erlich's mother is very proud of her boy.

I bring all this up because Erlich burst out laughing when I told him about my report and told me about his own.

"I also get that on the left side," he said. "Everything is cool. Many smart people end up there."

Erlich explained that he designed the program to make people cautious about the connection between genes and intelligence. All those disclaimers and notes that surrounded the bell curve were intended to show that these predictions are, in a sense, worse than just wrong. They're practically meaningless.

The inspiration for the program was a 2017 study pinpointing certain genes with some sort of connection to intelligence. For decades,

scientists knew that the genes we inherit play a role in the variation in scores on intelligence tests. Studies on twins and families show that people who share more genes in common tend to get closer scores. The 2017 study, carried out by a team of researchers based at Vrije University Amsterdam, was one of the first to find a statistically strong connection between that variation in scores and *specific* genes.

DNA is composed of four units, known as bases, that are a bit like the alphabetic letters that spell out a recipe. For the most part, the DNA of any two people is identical. But here and there, the letters differ. In a study of over 78,000 people, the Amsterdam team found variants in 52 genes that are unusually common in people who score higher (or lower) on intelligence tests.

This kind of study is very different from the genetic tests that doctors order for patients. If a woman has a family history of aggressive breast cancer, for example, a doctor may order a test for mutations on the BRCA1 gene. A single mutation there can raise the risk of breast cancer by 50 to 85 percent.

If you discovered that you had one of the variants identified by the Amsterdam team, that would not jack up your IQ by 50 points. Each one is only associated, on average, with a shift of a fraction of one point.

Erlich's program checks those 52 genes in the DNA of his volunteers. It determines the effect that each variant has on each person, adding up all the slightly positive and negative effects to determine their total impact.

In most cases, they all pretty much cancel each other out. That's why Erlich ended up with a bell curve, with its peak around a net effect of zero. In my case, the score-lowering variants slightly outweighed the

score-raising ones, leaving me—like Erlich—on the left side of the curve. And I do mean *slightly*. Each of those ticks on the horizontal axis of the bell curve represents five IQ points. Erlich predicted that the effect of my 52 genes added up to less than a point.

But there's an even deeper illusion to my bell curve: The seeming precision is almost certainly wrong.

When geneticists use the word *prediction*, they give it a different meaning than the rest of us do. We usually think of predictions as accurate forecasts for particular situations. At a carnival, you might encounter a man who promises to predict your weight simply by looking you over. If you weighed, say, 130 pounds, and he guessed 132, you might be impressed. If he guessed 232, you'd expect to walk away with a giant teddy bear.

Geneticists are a lot more forgiving about predictions. When they try to predict a trait from a set of genes, their prediction may be dead on, or it may be no better than random. Or, as is almost always the case, it is somewhere in between.

Genes that predict the variation in a trait perfectly in a group of people have a predictive power of 100 percent. If they're no better than what you'd get from blind guesses, their power is zero. The Amsterdam team tested their 52 genes on thousands of people and concluded that the genes have a predictive power of nearly 5 percent. Their predictions are less than random, but if you used them to predict individual people's intelligence, you'd give away a whole lot of teddy bears.

This weak power is no surprise to scientists who study the heredity of height, blood pressure, and other complex traits. Their variations arise from many genes—sometimes thousands of them—as well as

variations in the environment.

That doesn't mean that scientists won't get better at predicting intelligence. Earlier this year, a team of scientists based at the University of Edinburgh published an even bigger study on intelligence, examining nearly a quarter of a million people. They identified 538 genes with clear-cut influence on intelligence test scores. Those 538 genes have a predictive power of about 7 percent. That still may not be good for carnival work, but it's approximately a 50 percent improvement on the power that existed less than a year before.

Scientists are now studying even bigger groups of over a million people, and it's likely their powers of prediction will jump yet again. But in years to come, they won't keep leaping to 100 percent. When researchers study identical twins, they find that their intelligence test scores tend to be closer than fraternal twins. But they're not identical. That's a sign that genes are not the only force that shapes our intelligence. In fact, only roughly half of the variation in intelligence test scores arises from variations in genes.

And many experts doubt that they'll get close to that upper limit. Studying intelligence is just hard. You can't measure it with a quick blood test. Instead, you have to get volunteers to take a lengthy exam.

Even if scientists only manage to reach a predictive power of 25 percent, we could learn a lot from their work. Researchers are already finding that genes linked to intelligence tend to do certain things and not others. A lot of them switch on when neurons divide into new neurons, for example. Social scientists could take DNA into account in experiments to determine the best ways to help children learn and stay in school.

But with millions of people flocking to sites like 23andMe and Ancestry.com to get reports on their genes, we have to wonder what will happen if they start handing out intelligence predictions.

After talking with Erlich, I fear it will turn out badly.

Direct-to-consumer testing companies are marketing themselves as our new oracles of the self. "This year, know you better," an ad for 23andMe exhorts. If people expect to get this knowledge from their genes, I doubt many will look past stark curves and simple scores and plow through the fine print about the complex nature of intelligence, what it means to make a genetic prediction, and how untrustworthy a score for one person can be.

If people get accustomed to getting these intelligence predictions for themselves, it's possible that they may want them for their children too. Some researchers have even called for using genetic data in schools to create "precision education" tailored to each child's DNA. Scientists I've spoken to have raised the possibility that parents using in vitro fertilization might pick out embryos according to their scores on those tests.

For his own part, Erlich hopes none of these things come to pass. "I'm afraid that this will be a distraction for society," he said. An obsession with slippery genetic predictions could turn people's attention away from other things that influence how children do in school and beyond —things like their family's wealth, the stress in their neighborhoods, the quality of the schools themselves.

"I'm afraid that policy makers won't focus on the real things that bother me about inequality and education," Erlich said.

Our inner landscape of DNA is an endlessly fascinating place. But we

have to also look up, and survey the cliffs and chasms of our social landscape, too.

We want to hear what you think about this article. Submit a letter to the editor or write to letters@theatlantic.com.