

DNA / By Gunjan Sinha / Photography by Roman Barrett

THE IDENTITY

THE IDE

DANCE

The battle between genes and the environment is over. As the dust settles, scientists piece together how DNA and life experience conspire to create personality. >>





Sandra Peña (left) and Marisa Peña, 32

Both work at MTV: Sandra is a graphic designer and Marisa is an event producer.

Sandra, who was born a few minutes before her twin, has clearly taken the role of big sister to heart. "I put her in line," says Sandra. "I have more self-control, and I shield her."

After their parents died unexpectedly, the Peña sisters were devastated—and another trauma was just around the corner. Sandra decided to strike out on her own, following her boyfriend to Germany. "I cried for days," says Marisa—it was the first time that the two had ever lived apart. "It completely backfired," agrees Sandra. "It broke me and my boyfriend up. She was all I thought about, and my boyfriend and I would just fight, fight, fight."

The sisters are now about as close as two people can be: They live together, commute to work together and hang out with the same people. But they don't ask each other for advice: "What advice can she give me, when I know what she's going to say?" asks Sandra.

Sandra and Marisa Peña, 32-year-old identical twins, seem to be exactly the same. They have the same thick dark hair, the same high cheekbones, the same habit of delicately rubbing the tip of the nose in conversation. They had the same type of thyroid cyst at the same age (18) in the same place (right side). When San Diego is mentioned, they both say, simultaneously and with the same intonation, "Oh, I love San Diego!" They live together, work one floor away from each other at MTV, wear the same clothes, hang out with the same friends. They even have the same dreams.

The sisters are as alike as two people can be. At the same time, they are opposites. Sandra is outgoing and confident; Marisa is reserved. They have the same pretty face, but those cheekbones make shy Marisa look mysterious and brooding, while Sandra looks wholesome and sweet. Sandra tends to speak for her sister: "Marisa's always been more quiet, more subdued, an introvert"; Marisa nods her assent. They see themselves as a duo—but more like complementary photo negatives rather than duplicates of each other. "I think we balance each other out," says Sandra. "Definitely," Marisa chimes in. Sandra begins, "In every family photo, I'm smiling, she's—" "I'm not," Marisa says with a laugh.

When their father passed away ten years ago from pancreatic cancer and their mother died soon after, the deeper differences between the two became obvious. Their family had been very loving and protective, and the sisters were traumatized by the sudden loss. But as Marisa sank into a depression, Sandra picked up and changed her life. She left San Antonio for Germany to live with her boyfriend. Marisa stayed put, catatonic with sadness. It was the first time the two had ever been apart.

Then, after a few months in Germany, Sandra headed to New York City—the buzzing metropolis in which she had dreamed of living since she was a teenager. Marisa soon followed Sandra, but when she arrived in New York, "She just couldn't let go of [her sadness]," says Sandra. "I didn't know what to do with her."



Debbie Quinn (left), stay-at-home mom, and Diane Schierer, nurse, 44

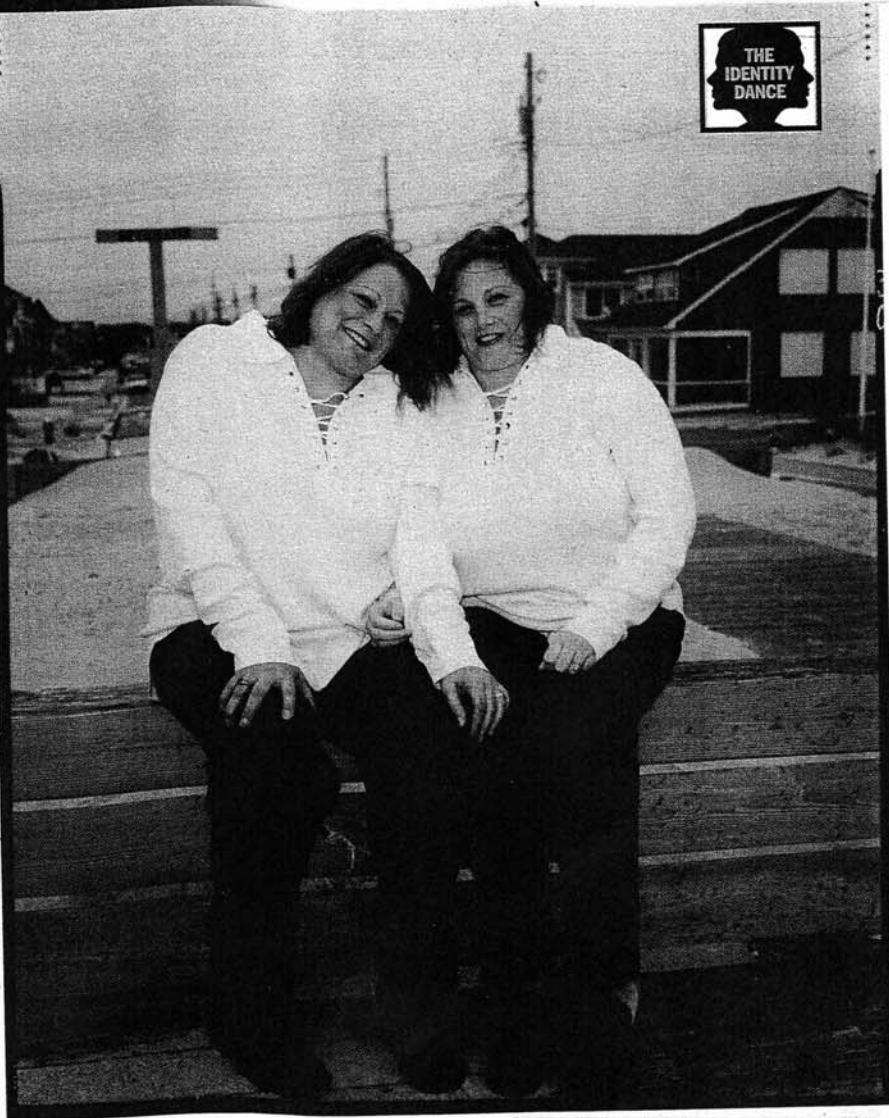
"Debbie's more like my mother, and I'm more like my father," says Diane. "When I try to give her advice, she gets upset. She thinks I'm always telling her what to do. I just think I have a stronger personality. Growing up, Debbie had a lot more boyfriends. I was a lot more standoffish. And when we would go to parties, she would drink more. I was always the designated driver."

Although they have quarreled seriously in the past—and even stopped speaking to each other at one point—the two sisters are close now, says Diane.

"I'm nice, and she's nasty," says Debbie. "She used to chase the boys home with a broom. Everybody says she always had a puss on her face, and I always smiled. It's true to this day. And she's always trying to tell me what to do. She acts like my mother."

» IN RECENT YEARS, WE'VE COME TO BELIEVE that genes influence character and personality more than anything else does. It's not just about height and hair color—DNA seems to have its clutches on our very souls. But spend a few hours with identical twins, who have exactly the same set of genes, and you'll find that this simplistic belief crumbles before your eyes. If DNA dictates all, how can two people with identical genes—who are living, breathing clones of each other—be so different?

To answer such questions, scientists have begun to think more broadly about how genes and life experience combine to shape us. The rigid idea that genes determine identity has been replaced with a more flexible and complex view in which DNA and life experience conspire to mold our personalities. We now know that certain genes make people susceptible to traits like aggression and depression. But susceptibility is not inevitability. Gene expression is like putty: Genes are turned on and off, dialed up or down both by other genes and by the ups and downs of everyday life. A seminal study last year found that the ideal breeding ground for depression is a combination of specific genes *and* stressful triggers—simply having the gene will not send most people into despair. Such research promises to end the binary debate about



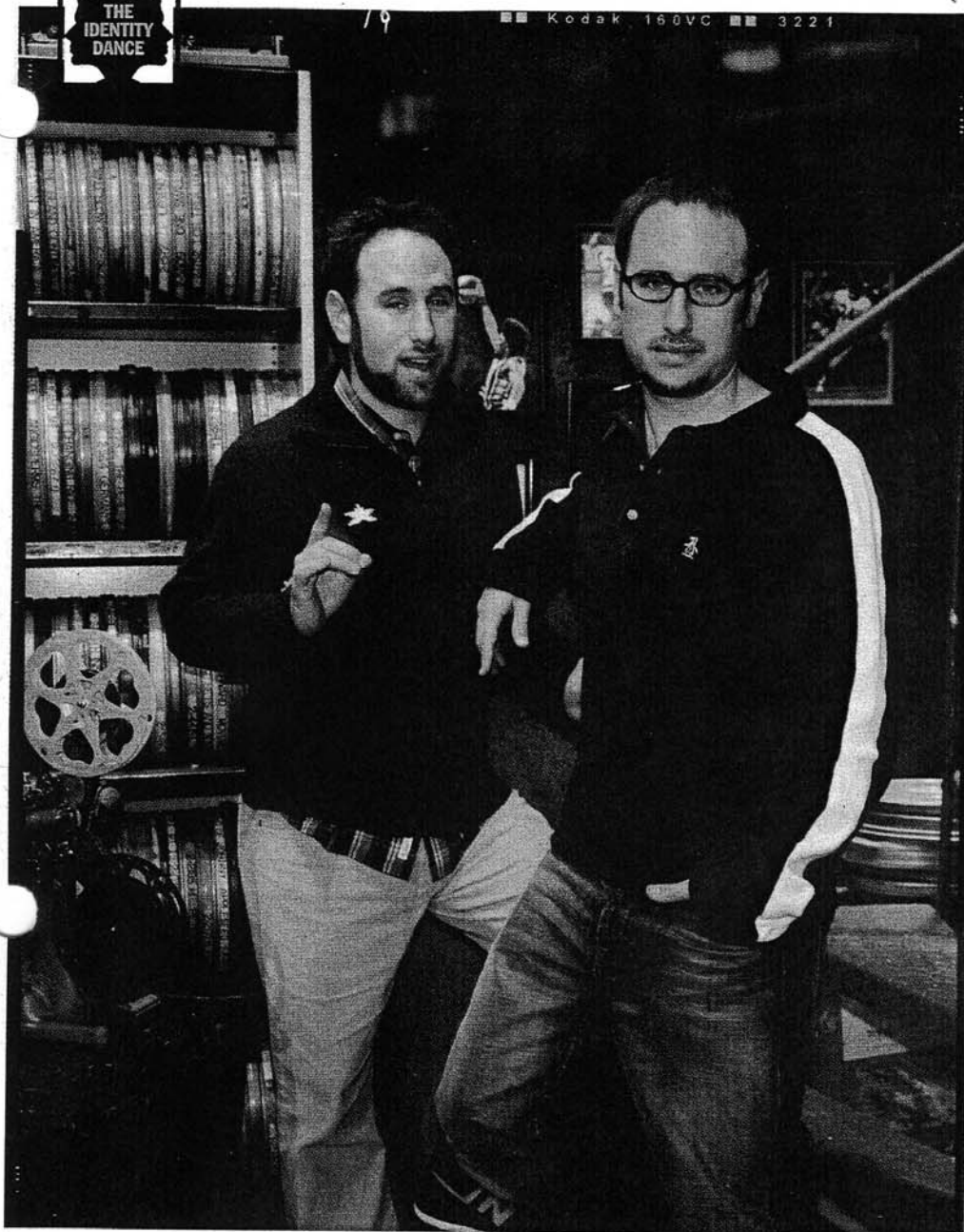
nature vs. nurture—and usher in a revolution in understanding who we are.

"While scientists have been trying to tease apart environmental from genetic influences on diseases like cancer, this is the first study to show this effect [for a mental disorder]," says Thomas Insel, director of the National Institute of Mental Health. "This is really the science of the moment."

About ten years ago, technological advances made it possible to quickly identify human genes. That breakthrough launched a revolution in human biology—and in psychiatry. Not only were scientists rapidly discovering genes linked to illnesses such as cancer and birth defects like dwarfism, they also found genes associated with such traits as sexual preference and aggression as well as mental illnesses such as schizophrenia.

Genetic discoveries transformed the intellectual zeitgeist as well, marking a decisive shift from the idea that environment alone shapes human personality. Nurture-

We've come to believe genes influence character more than anything else—DNA seems to have its clutches on our souls.



Randy Sklar (left) and Jason Sklar, comedians, 32

The brothers are “different shades of the same color,” according to Jason. They share a creative sensibility and have toured the country with their stand-up comedy act. They’ve also had a show on MTV (*Apartment 2F*).

Yet they live apart and have slightly distinct styles: Their friends can even tell them apart on the phone. “It’s subtle, but they know how I say hello,” Randy says.

Other differences are more revealing. For example, “Putting together an Ikea cabinet,” says Jason, “Randy would just be done as quickly as possible. If there were extra screws, he’d throw them behind the washing machine. I would look at the directions for so long before I dove in—and then still get it wrong.”

What’s for certain: They have no extrasensory twin perception. When the brothers were 14, they were involved in a university study investigating reports of telepathy between twins. Randy sat in one room looking at shapes, and Jason was supposed to draw them. “Not only did we show no telepathy, I was so far off, they ended up stopping the study,” Jason says. “I felt kind of bad about that.”

Behavioral genetics had a simple argument: Bad parenting, poor neighborhoods or TV didn’t cause bad behavior. Genes did.

» heavy theories about behavior dominated in the 1960s and 1970s, a reaction in part to the legacy of Nazi eugenics. By the 1990s, the genome was exalted as “the human blueprint,” the ultimate dictator of our attributes. Behavioral geneticists offered refreshingly simple explanations for human identity—and for social problems. Bad parenting, poor neighborhoods or amoral television didn’t cause bad behavior; genes did. No wonder all those welfare programs weren’t working.

“People really believed that there must be something exclusively genetically wrong with people who are not successful. They were exhausted with these broken-hearted liberals saying that it’s all social,” says Andreas Heinz,

professor of psychiatry at Humboldt and Freie University in Berlin, who has been studying the influence of genes and environment on behavior for years. The idea that violent behavior in particular might be genetically “set” was so accepted that in 1992, the director of the agency overseeing the National Institute of Mental Health compared urban African-American youth with “hyperaggressive” and “hypersexual” monkeys in a jungle.

Genetic explanations for behavior gained ground in part through great leaps in our understanding of mood disorders. In the early 1990s, research at the federal labs of Stephen Suomi and Dee Higley found that monkeys with low levels of serotonin—now known to be a major player in human anxiety



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» and depression—were prone to alcoholism, anxiety and aggression. Around the same time, Klaus-Peter Lesch at the University of Würzburg in Germany identified the serotonin transporter gene, which produces a protein that ferries serotonin between brain cells. Prozac and other drugs work by boosting levels of serotonin in the brain, so this gene seemed like an obvious target in the search for the genetic roots of depression.

Lesch, who was working on the connection between this gene and psychiatric disorders, later found that people who had at least one copy of the short version of this gene were much more likely to have an anxiety disorder. Short and long versions of genes function much like synonymous words: Different lengths, or “spellings,” generate subtle but critical differences in biology.

Despite these groundbreaking insights, it quickly became clear that complex human behaviors couldn't be reduced to pure genetics. Apart from a few exceptions, scientists couldn't find a gene that directly *caused* depression or schizophrenia or any other major mental or mood disorder. The new research also failed to answer a lot of common-sense questions: If identical twins are genetically indistinguishable, how could just one end up schizophrenic or homosexual? And it couldn't address subtler questions about character and behavior. Why do some people bounce back from terrible trauma that shatters others? Why are some people ruthlessly ambitious and others laid-back?

THANKS TO MISFIT MONKEYS LIKE George, a rhesus macaque living in a lab in Maryland, researchers have clues to the missing element. In most ways, George is a typical male monkey. He's covered in sandy fur and has a rubbery, almost maniacal grin. But a couple of things set George apart. After he was born, Higley and Suomi's team separated George from his mother, raising him instead in a nursery with other macaque infants his own age. George has another strike against him: a short version of the serotonin transporter gene (monkeys, like people, can have either a short form or a long form of the gene).

But the most notable thing about George is that he is an alcoholic. Each day, George and his simian chums have happy hour, with alcohol freely available in their cage for one hour. Unlike his buddies, George drinks like

the resident barroom lush—he sways and wobbles and can't walk a straight line.

And his problems go beyond the bottle. He's reluctant to explore new objects, and he is shy around strangers. He always seems to be on edge and tends to get aggressive and impulsive quickly. In short, he's a completely different animal from his cousin Jim, who also has the short version of the transporter gene but was raised by his biological mom. Jim's “normal” upbringing seems to have protected him from the gene: This monkey is laid-back and prefers sugar water to booze.

After studying 36 family-raised monkeys and 79 nursery-raised animals, the team found that the long version of the gene seems to help the animals shrug off stress. The short form of the gene, by contrast, doesn't directly *cause* alcoholism: Monkeys with the short gene and a normal family upbringing have few personality problems. But the short version of the gene definitely puts the animals at a disadvantage when life gets tough. Raised without the care and support of their mothers, their predisposition toward anxiety and alcoholism comes to the fore.

“Maternal nurturing and discipline seem to buffer the effect of the serotonin gene,” says Suomi. “If they don't have good mothers, then the [troubled] behavior comes out loud and clear.”

The implications of this research are tantalizing, since people also carry long and short versions of the transporter gene. These variants, unlike those that have been identified as making people susceptible to diseases like breast cancer or Alzheimer's, are very common: Among Caucasians, about one-fifth of the population has two copies of the short gene (everyone gets one copy from Mom and the other from Dad), and another third have two copies of the long gene. The rest have one of each. (The gene has not yet been studied in other populations.) The evidence indicated that this gene was related to resilience and depression in humans. Why, then, had researchers thus far failed to find a convincing correlation between the gene and the risk of depression?

Terrie Moffitt and Avshalom Caspi, a husband-and-wife team of psychologists at King's College in London, had the insight that environmental influences might be the missing part of the puzzle: Moffitt and Caspi turned to a long-term study of almost 900



Pam Spiro Wagner (left), poet; Carolyn S. Spiro, psychiatrist, 51

Growing up, Pam was the “smart one,” more assertive and outspoken than her sister. She still wins prizes for her poetry, but since young adulthood, she’s also been struggling with schizophrenia, a disorder that often lands her in the hospital. Shy Carolyn is now a psychiatrist—she began her studies before she fully realized what was troubling her sister.

The two are now jointly writing a memoir, *Solo for Two*, due to be released in early 2005.

“Our first word, after *mama*, was *we*, which meant *I*. We weren’t merely similar and separate, we were—we knew—one,” writes Pam. “Basically, we had no concept of being separate” until the beginning of school, Carolyn adds. At age 6, Pam broke her leg on a ski trip—and Carolyn felt so betrayed she refused to speak to her wounded sister. “I just didn’t understand how she could have a broken leg, and I didn’t,” says Caroline. At 17, the two were in a car wreck that injured a motorcyclist. Pam was driving, but Carolyn feels like it was her fault, too: “We were driving the car.”

Even though Pam’s illness makes her delusional and suicidal at times, the sisters relate to each other well. “I still feel like Lynn timer understands it all, that she’s been through it with me,” says Pam. “It’s sort of jarring when I have to explain it to her, because I think, ‘She was there with me.’”

New Zealanders, identified these subjects’ transporter genes and interviewed the subjects about traumatic experiences in early adulthood—like a major breakup, death in the family or serious injury—to see if the difficulties brought out an underlying genetic tendency toward depression.

The results were striking: 43 percent of subjects who had the short genes and who had experienced four or more tumultuous events became clinically depressed. By contrast, only 17 percent of the long-gene people who had endured four or more stressful events wound

up depressed—no more than the rate of depression in the general population. People with the short gene who experienced no stressful events fared pretty well too—they also became depressed at the average rate. Clearly, it was the combination of hard knocks and short genes that more than doubled the risk of depression.

Caspi and Moffitt’s study, published last summer, was one of the first to examine the



Mothers of multiples will tell you their babies were distinct the moment they were born.

» combined effects of genetic predisposition and experience on a specific trait. Psychiatrists were delighted. "It's just a wonderful story," says Insel. "It changed the way we think about genes and psychiatric disorders."

Moffitt and Caspi have found a similar relationship between another gene and antisocial behavior. Abused and neglected children with a gene responsible for low levels of monoamine oxidase in the brain were nine times more likely to engage in violent or other antisocial behavior as adults than were people with the same gene who were not mistreated. Finnish scientists have since found similar effects on genes for novelty seeking—a trait associated with attention deficit hyperactivity disorder. Children who had the genes and who were also raised by strict, emotionally distant parents were much more likely to engage in risky behavior and make impulsive decisions as adults than children with the same genes who were raised in more tolerant and accepting environments.

While scientists don't exactly know how genes are influenced by environment at the molecular level, there are clues that genes have the equivalent of molecular "switches" and can be programmed—turned on or off,

up or down—very early. Both Lesch and Suomi have shown that the level of biochemicals such as the serotonin transporter molecule can be "set" as early as in the womb, at least in mice and monkeys.

The prenatal environment also has a major influence on differences between identical twins. Mothers of multiples will tell you that their babies were distinct the moment they were born, and research backs them up. Twins experience different environments even in the womb, as they compete with each other for nutrients. One can beat out the other, which is why they often have different birth weights: Marisa Peña is a bit taller and heavier than her sister.

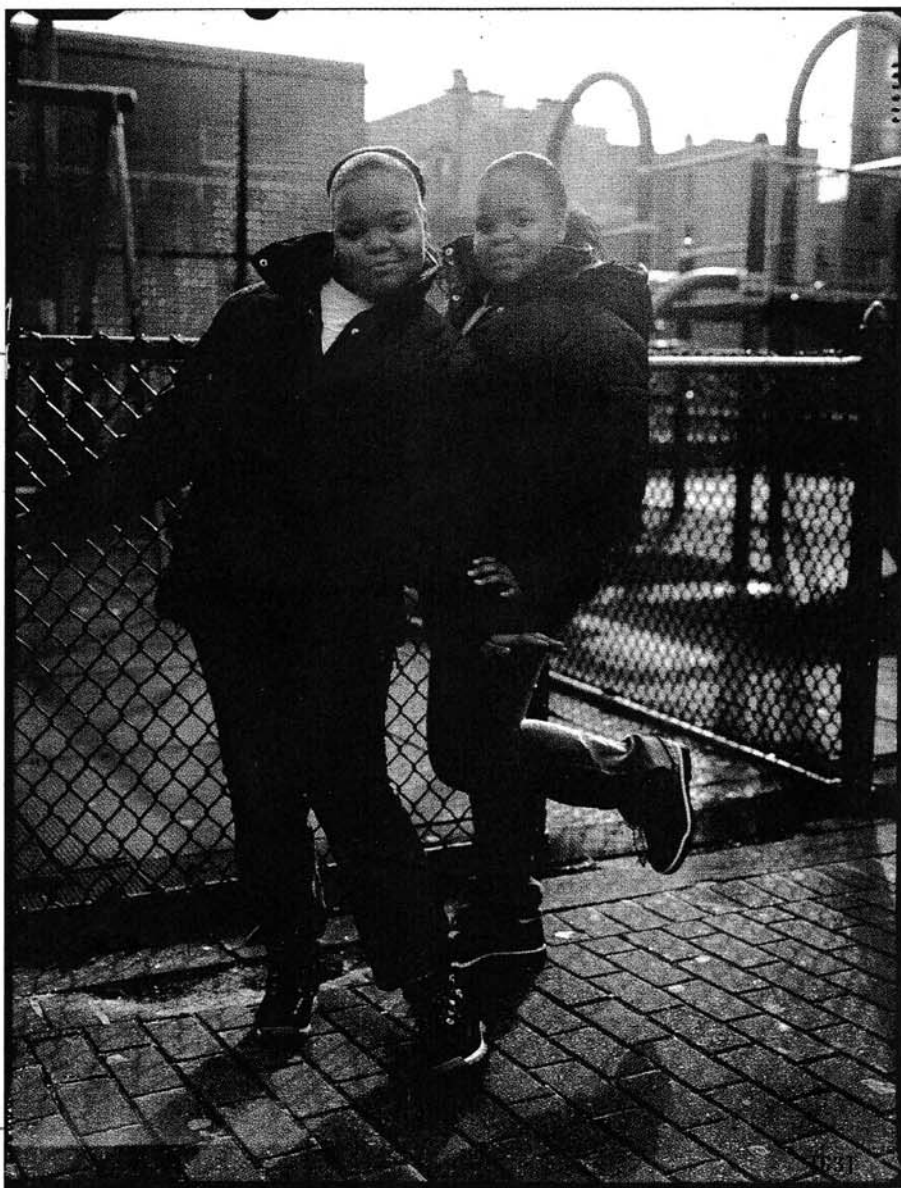
Prenatal experiences are just the first in a lifetime of differentiating factors. Only about 50 percent of the characteristics twins

Sha-Asia (left) and Na-Asia Jones, 13

These girls insist that they are as different as two sisters the same age can possibly be. They go to the same school but are in different classes and have different friends. They don't agree on boys: Na-Asia, wiggling a ring on her finger, is confident that she'll eventually marry Lil' Fizz of the hip-hop group B2K; Sha-Asia is more interested in rapper Lloyd Banks of G-Unit.

They both insist it's only an accident when they finish each others' sentences—something any sister might do. But "because we're twins, people think there's something special about it," Na-Asia says.

Still, they keep close track of each other's taste in clothes, in books and in food. "Even when it's 110 degrees, they'll be lying on top of each other to sleep," their mother, Tonya Nunn, says—although Sha-Asia says that's only because the bottom bunk is closer to the bathroom.



THE IDENTITY DANCE CONTINUED

Prenatal experiences are just the first in a lifetime of differentiating factors. Only about 50 percent of the characteristics twins have in common are due to genes alone. Researchers now believe that an illness suffered by only one twin, or different amounts of attention from peers or parents, can set the stage for personality differences. This makes it easier to understand why the Pena sisters reacted as they did: By the time their parents died, "these twins had had a lifetime of experiences which might have made them react differently," says Moffitt. "In addition, some pairs of identical twins individuate themselves in early childhood. They seem to take on the roles of 'the shy one' and 'the outgoing one' and then live up to those roles." In other words, they customize their environment, and the world treats them accordingly.

The new science of nature and nurture isn't as straightforward as the DNA-is-destiny mantra, but it is more accurate. "People have a really hard time understanding the probabilistic nature of how genes impact traits like depression," says Kenneth Kendler, director of the Virginia Institute for Psychiatric and Behavioral Genetics at Virginia Commonwealth University, who heads a major twin registry. "They think that if something is heritable, then it can't be modified by the environment." The knowledge that the traits we inherit are also contingent on what the world does to us promises more insight into why people act and feel differently—even when they look exactly the same.