

JOSH FISCHMAN

Criminal Minds

FROM THE CHRONICLE OF HIGHER EDUCATION

There is now evidence that connects the size and nature of certain features of the brain to criminal behavior. Josh Fischman looks into whether this means we will be able to predict which children will grow up to be killers.

HE WAS LOCKED IN A VAN IN ENGLAND WITH VIOLENT criminals, repeatedly, during his late 20s, says Adrian Raine, lifting a fork of salmon ravioli from his plate at a tony restaurant on Walnut Street. "I was at the maximum-security prison in Hull," says the psychologist, now in his 50s, and his job involved attaching polygraph-type sensors to the prisoners' skin to measure their agitation as he bothered them with loud sounds and flashes of light. His lab was in the back of the van, he says, "and the guards were very concerned these men would commandeer the vehicle and escape."

Their solution? "Take my keys away and lock the doors from the outside."

Raine, now chair of the criminology department at the University of Pennsylvania, a few blocks from the restaurant, stops eating for a moment to remember. "So there I was, in this very tiny space. And I kept watching the needles these sensors were connected to, for I imagined that the first sign these men were about to rush me would be the needles starting to swing wildly as the men got excited and prepared to attack."

They never did. Raine always got out of the van unscathed, but the slightly built, graying Englishman has never strayed far from the company of killers, wife batterers, and psychopaths. He has spent a career trying to spot ever-earlier signs of dangerous minds—clues to bad behavior even before a criminal commits a crime.

Along with several other researchers, he has pioneered the science of neurodevelopmental criminology. In adult offenders, juvenile delinquents, and even younger children, dozens of studies have pointed to brain features that seem to reduce fear, impair decision making, and blunt emotional reactions to others' distress. The studies have also highlighted body reactions that are signs of this pattern and are tied to criminality.

Society has always wondered about "bad seeds," people who seem to be possessed by devils. But what is emerging from this research is a cluster of biological markers that plant the bad seed in the brain. More striking, they appear to predict antisocial behavior even before it happens. Early warnings could avoid a world of hurt, because some of these people are terribly dangerous. Kent A. Kiehl, an associate professor of psychology at the University of New Mexico, has described in *The New Yorker* a psychopath whom he encountered during his research: The man started with petty crimes as a child and was convicted of arson by age 17. After a prison stretch, he moved back in with his mother, got in an argument with her, and wrapped the phone cord around her neck when she tried to call for

help. He then threw her down some stairs, stabbed her several times, crushed her head beneath a propane canister, and went out to celebrate with a three-day bender.

"So if I could tell you, as a parent, that your child has a 75-percent chance of becoming a criminal, wouldn't you want to know and maybe have the chance to do something about it?" asks Raine.

But predicting criminality makes a lot of people nervous. It raises the specter of earlier scientific episodes in which researchers claimed that aspects of biology—like ethnic background—determined behavior or intelligence. With what everyone admits is still a young and imperfect science, there is also the possibility of getting it wrong, and ruining someone's future with an undeserved "bad seed" label.

Still, Raine has many supporters. "He really has a broad range of work," says Abigail A. Marsh, an assistant professor of psychology at Georgetown University who has studied brain areas related to psychopathy. "I'm particularly impressed with his long-term studies, where he's traced physical patterns in children to conduct problems in adulthood, because doing that kind of research is difficult."

Raine himself acknowledges that he's going down a dangerous path. "The brain changes. Family and the environment may protect it and may even alter some of the physiology that we see," he says. "So we don't want to say that biology is destiny." Indeed, he is in the midst of an experiment with young children who show some markers of aggressive behavior, to see if psychotherapy or a diet rich in brain-protective supplements can reduce chances of antisocial acts.

"Of course, all of this brings up tremendously difficult ethical questions," he says. "But I don't think I'd be doing my job unless I said that we need to start talking about them. It's time we start this discussion, before we start labeling people."

THE NOTION OF A CHANGEABLE brain was not at all part of the last serious scientific attempt to link physical traits to behavior or

thinking. In the 19th century, physical anthropologists like Paul Broca and Paul Topinard—founding figures in the field—took calipers to skulls and scales to brains to show that specific brain shapes were features of particular races or groups, and that the mental abilities of those races followed those shapes almost without fail. There was the “facial angle,” a degree of forward thrusting that was supposed to mark intelligence. Europeans purportedly had an angle of 80 degrees, Africans of 70 degrees, and apes rather less. The method was called craniometry, and it served an assumption that racial differences were primordial and showed up as immutable mental characteristics. (Phrenology, a pseudoscience that tied various bumps on the head to fine-grained personality traits, was never taken seriously by researchers.) The notion began to unravel when other scientists, like Franz Boas in the early 20th century, took up their own calipers to show that the anatomy of a race in fact shifted across generations.

And as Raine points out, the individual brain does change. Beginning in the 1960s, scientists began amassing evidence of “plasticity” when they found brain regions taking on new functions to make up for injury. In the 1980s and 1990s, they established that animals generate new neurons when they learn new skills. They also found that human babies reshape their brain pathways as they grow. Anatomy at birth may influence many things, but it is not fate.

It was in that environment that Raine began exploring psychology. He was born the son of a bricklayer and an ice-cream vendor in Darlington, in the north of England. During a brief flirtation with an accountant’s career (“I was a boring kid and good with numbers,” he says), he was wandering in a bookstore one weekend afternoon. “I came across a book by psychiatrist R.D. Laing on how faulty family communication can make you a schizophrenic. It was like an epiphany for me, reading about this effect on brain and behavior. So then I wanted to go to university and be a psychiatrist.”

The university turned out to be Oxford—Jesus College—where

Raine vacillated between wanting to be an experimental psychologist and wanting to teach primary school. That second impulse, though not followed through, was fateful. Student teaching “showed me there were some kids who were just bullies, very extreme, and I wondered, Why? Where did the behavior come from? Why were some kids angels and some devils?”

He made the topic into his doctoral research at the University of York, where he began using the lie-detector-like sensors, later featured in his prison van, to measure heart rates and changes in the way the skin conducts electricity in teenagers with varying degrees of aggression.

But after he got his degree, he couldn’t get a job. “Biological explanations were not popular at that time, the late 1970s. It was not on anyone’s radar screen at all. I sent out 67 job applications, to universities as far away as Papua New Guinea, and I got 67 rejections. The only place that would take me was prison.”

As a prison psychologist at Hull, starting in 1980, he worked with rapists, murderers, and pedophiles. That was also the year that Robert D. Hare, now an emeritus professor at the University of British Columbia, published the first checklist that could single out psychopaths from other personality types, and Raine began trying various interventions with that group. “The main thing that I learned was that I really can’t change these people,” he says. “It brought me back to kids, to earlier stages, thinking we’ve got to look at the earlier, predisposing factors, when maybe we can do something.”

After two years at Hull and two at another prison, Raine broke out of jail and into academe, first at the University of Nottingham and then at the University of Southern California, always pursuing those predispositions. One of his major lines of research was long-term studies of children, measuring physiological reactivity at young ages to see if any pattern related to bad behavior decades later.

Testing and following children for years is not, as Georgetown’s Abigail Marsh says, a simple thing to do. They tend to drop out,

move away, disappear. But Raine lucked into a major source of data. In the late 1960s, the World Health Organization had started a project to closely follow about 1,800 children on Mauritius, a small island nation in the Indian Ocean. The nice thing about remote islands: People don't tend to move away and disappear.

Over the years, Raine and several colleagues have shown that children from Mauritius who show slower heart rates and reduced skin responses when annoyed by loud tones or challenging questions tend to have criminal records when they get older. In 1996 the researchers showed that 15-year-olds with this pattern tended to have criminal records by age 29. In 2010, the age was pushed back further: 3-year-olds who had those physical responses were rated by teachers as more aggressive than other children five years later.

But when such kids got better schooling and nutrition starting at age 3, they had more typical physical reactions. And by age 23, their incidence of criminal behavior dropped by 35 percent.

There is a theory behind this, and it's about being insensitive to fear. Normally, a startling noise races the heart and sends the body into a high state of alert, which is what the skin electrodes pick up. But research indicates that children who are not alarmed don't react to the threat of punishment when they misbehave. Nor do they react to the distress shown by other people. They don't learn that their bad actions, like causing others pain, have bad consequences for those people. The pattern builds on itself until—maybe—it creates a person who wraps a telephone cord around his mother's throat.

Another line of evidence supporting this idea—the cold-blooded criminal—comes from studies of young twins who have what are called callous, unemotional traits. At Southern California, Raine was part of a team studying 605 families of twins. Some of the twins were identical, sharing 100 percent of their genes, and some were nonidentical, sharing 50 percent. When identical twins show more similar traits than nonidentical pairs, it most likely means that genes have a stronger influence than environment, because all of the twins were raised in the same surroundings.

In Raine's twins studies, when the children were ages 9 and 10, researchers gave them a battery of psychological tests to assess aggression and antisocial behavior. They also asked three different kinds of observers—parents, teachers, and the children themselves—to rate the children's antisocial tendencies: The results showed that these traits were more consistent in the identical pairs. "I think at least 50 percent of this can be attributed to genetics," Raine says.

More recently, Nathalie M.G. Fontaine, an assistant professor of criminology at Indiana University at Bloomington, and a team of researchers have followed more than 9,000 sets of twins in England and Wales from the time they were 4 through age 12. Those young children in whom parents and teachers saw repeated callous behavior and lack of emotion were the ones most likely to have patterns of lying, cheating, and stealing by age 12. Moreover, "biology appears to play a role in this," Fontaine says, because traits appear to be carried across twins. "In boys with high CU [callous, unemotional] traits, for example, we think 78 percent of their CU traits are inherited," she said when she presented the findings at this year's meeting of the American Association for the Advancement of Science.

After years of observing behavior like this, and noting its repeated connection to dulled nerves, Raine began wondering what blunted the senses. Ultimately, of course, all nerves connect to the brain. So was there something actually in the brains of these people that tied into this lack of fear, lack of sensitivity, and abundance of mayhem?

Others had been considering the same thing. Antonio R. Damasio, a pioneering professor of neuroscience, was one of the first to demonstrate that damage to parts of the brain is tied to antisocial actions, in work done during the 1990s at the University of Iowa. (He is now at Southern California.) He focused on the amygdala, a small, almond-shaped area in the middle of the brain known to help process emotions. In patients with lesions in the region, he observed a repeated pattern of bad decisions, like making risky bets while gambling. Cut off from emotional reactions, these people lacked an alarm bell that

signaled a poor choice. They could see many courses of action but, shorn of feedback from the amygdala, couldn't tell good from bad. That extended to reading other people's emotions, too: The patients had trouble distinguishing frightened expressions from happy ones. James R. Blair, a neuroscientist at the National Institute of Mental Health, has found these abnormalities to be especially common among psychopaths, which could explain their unsettling ability to hurt other people horribly yet feel no remorse at all.

Damasio also found that damage to the prefrontal cortex, a brain area involved in decision making, could turn mild-mannered patients into rash, destructive individuals, seeming to rob them of a "brake" on their impulses. This led him to propose that the two regions normally link up to prevent people from harming others by generating emotional alarm (the amygdala) and acting on it (the prefrontal cortex). When either part of the chain is damaged, antisocial actions result. Damasio called this "acquired sociopathy."

In 1997, Raine and several colleagues put the theory to the test on real killers. They compared the functioning of the brains of 41 convicted murderers with those of 41 normal people. Using positron emission tomography, or PET, a type of scan that measures the activity in areas of the brain, they saw lower activity in both the prefrontal cortex and the amygdala of the murderers' brains.

When they further divided murderers into those who came from "good" homes and those who came from "bad" homes—those filled with neglect, abuse, and poverty—the first group again showed lower activity in the prefrontal cortex, in particular an area called the orbitofrontal cortex. Raine's interpretation: Genetics and anatomy were more influential on their development than was the way they grew up; the murderers from good homes seemed to be terribly affected by this low-functioning brain region.

And it wasn't just function. Brain form was also impaired, Raine and his coworkers found. A series of studies using magnetic resonance imaging, which reveals structures and shapes, showed that

criminals and people who scored high on tests of antisocial disorders had different-looking brains. Both the orbitofrontal region and the amygdala were smaller than normal. And the corpus callosum, the bridge between the brain's two hemispheres that helps them communicate, was abnormally large.

But those findings raised a chicken-and-egg type question: Did the brain features produce the behavior, or did the behavior change the brain? Violent criminals are known to bang their heads into walls and abuse drugs, and both of those things damage the brain, possibly producing the shrinkage Raine was seeing on the brain scans. He needed to go back even further, to birth and beyond.

YOU CAN'T PUT A FETUS in a brain scanner. What you can do, however, is look for a defect that begins before birth and can still be detected in adults. Raine found it in a hole in the head. More precisely, a thin wall of brain tissue that separates a hole—all brains have these spaces—into two. The hole appears during the 12th week of a fetus's development, and the wall—pushed forward by a normally developing amygdala and other brain areas—divides it by the 20th week. When the wall doesn't form completely, a condition known by the jawbreaking name of *cavum septum pellucidum*, it's usually a sign of abnormal development in the amygdala and other structures. Years later, in adults, the failed wall can be spotted in a brain scan.

Raine, who moved in 2007 to the University of Pennsylvania, found that the condition is also associated with dangerous minds. In a 2010 paper, he and his colleagues compared people with and without the feature on several fronts. The groups were tested for antisocial personality disorder, psychopathy, and aggression. Their records were searched for criminal arrests and convictions. In every single one of those areas, there were a lot more men and women with the wall defect. Here, finally, was evidence tracing criminality back to

the womb, before any head-banging could occur. It was evidence of changes in the brain that nicely tied in with the abnormalities seen in adult criminals.

"I think there's no longer any question, scientifically, that there's an association between the brain and criminal behavior. We're beyond the point of debating that," says Raine. "Every study can be criticized on methodology. But when you look at the whole, at all the different designs, it's just hard to deny there is something going on with biology."

Indeed, the evidence keeps coming: This month a team of researchers from the Universities of Cambridge and of Southampton reported that 15-year-old kids with conduct disorders had smaller amygdalae than those with no behavior problems; the more severe the disorder, the greater the shrinkage. Some genes have even been linked, tentatively, to these conduct disorders.

So what do we do now?

One thing we don't do, says Fontaine, is mark children as future criminals. "No way! I would never put a risk number on a specific child," she says. "We are talking about groups, not individuals. We don't know what will happen with any one child, because there are also protective factors." The plastic, changeable brain means that a strongly supportive family, or an influential schoolteacher, or religion could blunt the effects of a hole in the head. Or as Damasio, who thinks Raine has produced a strong body of evidence, puts it: "The changes are themselves changeable."

Raine himself is a big believer in protective factors. "You can't make a lesion to the prefrontal cortex and, hey presto, you get a criminal. It's not like that," he says. "Of course social factors are critically important." In his current study of Philadelphia children with the slow physical reactivity that has been linked to trouble, some are getting a diet rich in omega-3 fatty acids and calcium to see if those protect brain cells, some are getting cognitive-behavioral therapy, and some are getting both to see if trouble can be staved off.

Still, the time is coming, Raine believes, when putting numbers on children will be tempting. If a 75-percent chance of a bad seed isn't high enough, he wonders, what about 80 percent? Or 95? "Look, I have two children, 9-year-old, nonidentical twin boys," he says. "And I'd definitely want to know, especially if there was a treatment that has a chance of success. But I realize not every parent will. We have to start having this conversation now, though, so we understand the risks and the benefits. It's easy to get on your moral high horse about stigma and civil liberties, but are you going to have blood on your hands in the future because you've blocked an approach that could lead to lives being saved?"

"One swallow does not a summer make. But together, this is a message in the sky."