



emotions

speech

language

murder

reasoning

perception

hearing



BODY OF EVIDENCE

NEUROCRIMINOLOGIST PROBES THE BIOLOGY OF CRIME

BY PETER NICHOLS

PHOTO BY CANDACE DICARLO

ILLUSTRATION BY MATTHEW LEAKE

In the mid-19th century, Italian physician Cesare Lombroso was doing an autopsy on Giuseppe Villella, a notorious brigand who'd spent years in the prisons of Pavia. Peering into the dead criminal's skull case, Lombroso thought it resembled the crania of "inferior animals," particularly rodents. "At the sight of that skull," he wrote, "I seemed to see all of a sudden, lighted up as a vast plain under a flaming sky, the problem of the nature of the criminal."

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Often credited as the father of criminology, Lombroso hypothesized that violent behavior could be explained by cranial, skeletal or neurological deformities. Some people were just “born criminal,” he reasoned. Biological malformations—“stigmata” he called them—suggested that lawbreakers were throwbacks to an earlier, more brutish stage in human evolution.

“He was fascinated by the idea that there was a biological brain difference between criminals and the rest of us,” notes neurocriminologist Adrian Raine. From that day on, Lombroso took careful measurements of faces, jaws,

criminals are physically and functionally different from the rest of us.”

Raine is chair of the criminology department. Before emigrating to the United States, he worked as a psychologist at two maximum-security prisons in England. But before that, he seemed to be heading for a place on the other side of the bars. Raine confesses to having been an “antisocial kid”: joining gangs, letting air out of tires, setting fire to mail and getting into the usual mischief of wayward kids. “I was one of these boys, but I didn’t end up in prison. Why? I’m still trying to answer the question, not just for myself personally but, I think, for all kids like me. Why did I change? That intrigues me.”

He likes the word “intrigue” and puzzles over the scattered bits of brain- and social-science data his research finds, trying to piece them all together into a coherent picture. Raine is one of the world’s leading researchers using neuroscience techniques to understand the roots of crime—how wrongdoing might be wired into the brain or even written into the genes of malefactors. It’s not that he spurns more conventional theories that point to failed social structures as sources of aggression and violence. “Our thoughts come from the brain,” he muses. “Our behavior comes from the brain, and there are social processes going on. I’m intrigued about how social processes can have an outcome like crime. Biology is the black box in the middle that we are just starting to open up.” Using the new tools and technologies of neuroscience, Raine is peering far deeper and more finely into the criminal brain than Lombroso ever could more than a century ago.

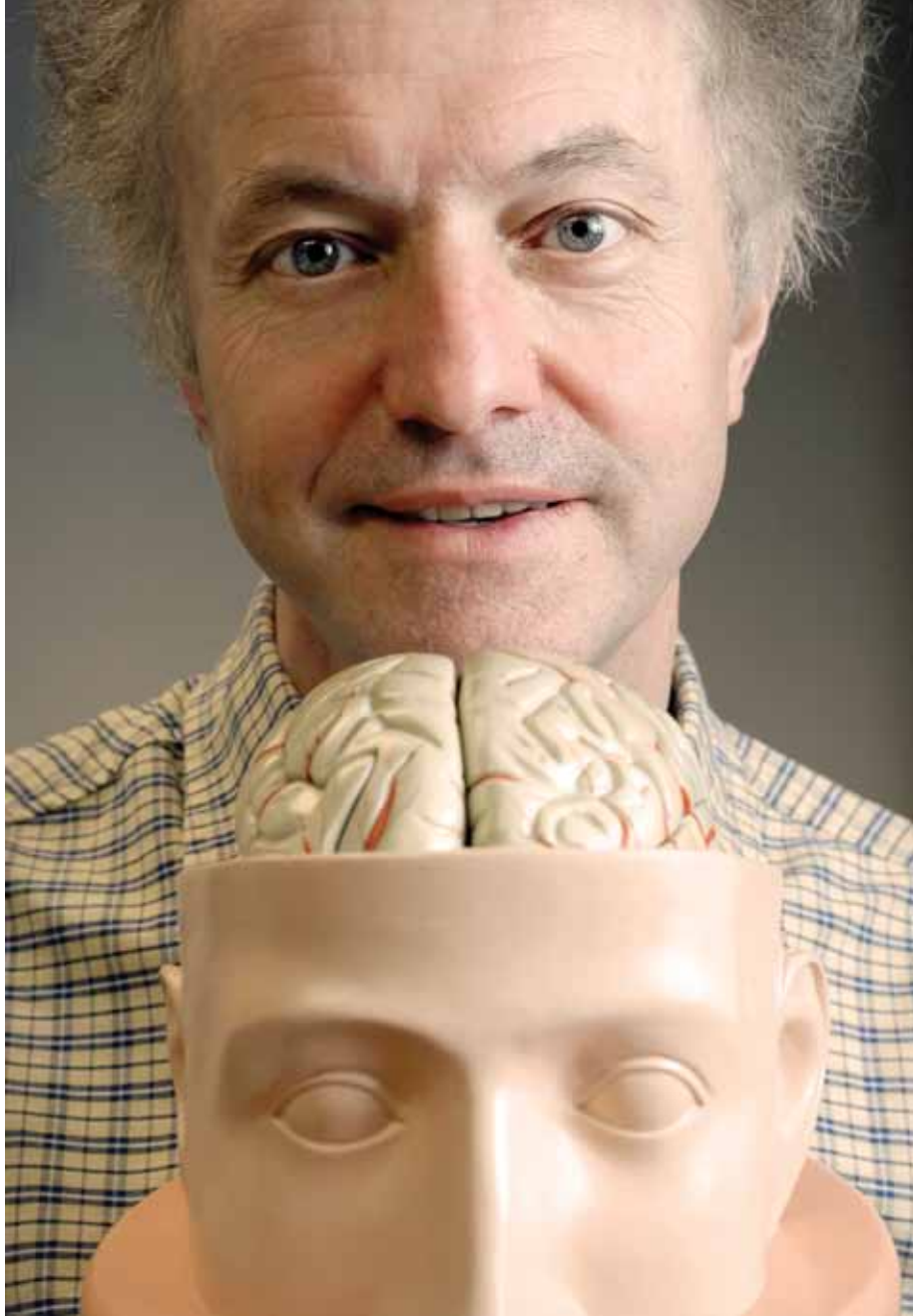
In a study of clients pooled from temporary employment agencies in Los Angeles, Raine tested and diagnosed a group with antisocial personality disorder. People with APD are chronic liars and coldly manipulative individuals who show a pattern of disregard for others. Together with a control group of temp workers, the brains of 21 APD clients were scanned using structural magnetic resonance imaging. The scans revealed that the volume of gray matter in the sociopaths’ prefrontal cortices was 11 percent less than in normal brains. The prefrontal cortices sits right behind the forehead and is the stop-and-think

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heights, weights and other physical traits to gather data in support of what he called his “revelation.”

Lombroso’s empirical and systematic study of offenders gave birth to the science of criminology, but the field almost immediately turned from the biological basis of crime to social, economic and family causes. Poverty, abuse, gangs, joblessness, racism, poor education, bad parenting and other more readily observable social deprivations were seized upon and explored as roots of crime. Biology was left behind.

“Lombroso’s theories sound a bit ridiculous to us,” Raine comments, “but in a way he was right.” With the emergence of new and powerful imaging technologies, scientists can see detailed pictures of the brain and trace activity along its neural networks. “The brain was forgotten until neuroscience techniques evolved to a level where we could, for the first time, really look at brain structure and function,” he says. “And from then on, we found that there’s certainly a brain basis to crime—that the brains of violent



Adrian Raine is the Richard Perry University Professor of Criminology and Psychiatry, and chair of Penn's criminology department. He also holds an appointment in the psychiatry department in the School of Medicine. The author of many science papers on the connections of crime to biology, his books include *Crime and Schizophrenia*, *The Psychopathology of Crime* and *Biosocial Basis of Crime*.

part of the brain where reasoning and decision making are processed. Raine calls it the “guardian angel” over impulses and aggressive feelings that rise up from the limbic system, an older, deeper region of the brain.

“Seventy-five percent of us have had homicidal thoughts,” he observes. “What stops most of us from acting out these feelings is the prefrontal cortex.” It turns out that the angel watching over these sociopaths has far fewer neurons on which to run the calculus that considers the cost of carrying out the dark prompts that come from the primitive brain.

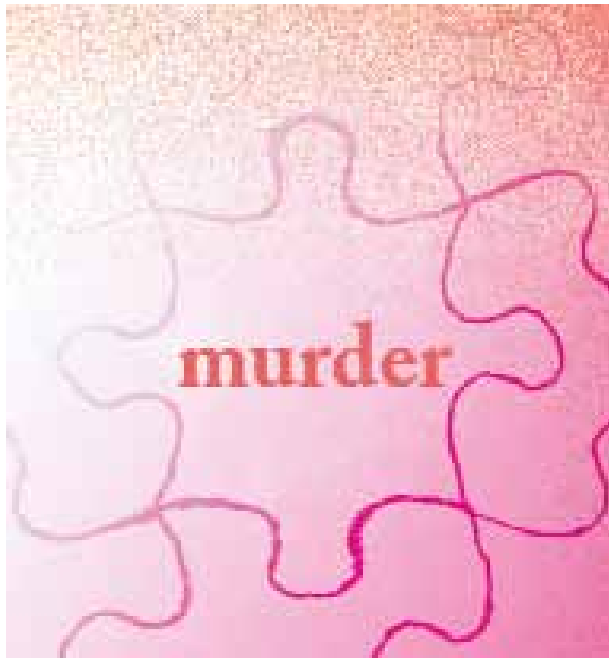
Related studies confirm the neural paucity of criminals’ prefrontal circuitry. Positron emission tomography (PET) makes a picture of brain activity by tracking injected radioactive chemicals that propagate along networks of firing

neurons. PET scans of 41 murderers and 41 control subjects carried out by Raine and colleagues revealed “significantly lower” neural activity in the prefrontal cortices of murderers. “When the prefrontal cortex is not functioning too well,” Raine speculates, “maybe an individual, when angry, is more likely to pick up a knife and stab someone or pick up a gun and pull the trigger.”

Looking deeper into the limbic brain, Raine did PET scans of the amygdala and associated circuits in the neural networks of convicted murderers who pleaded not guilty by reason of insanity. A critical module in the brain circuitry that processes emotion, the amygdala is activated when people are solving moral dilemmas and occupied with feelings about what is right and wrong. In scans of normal brains parsing a moral conundrum, the amygdala

lights up. In psychopathic brains, it is noticeably dimmer. “The feeling for what’s right makes most of us behave in a moral way,” says Raine. “Psychopaths break all the rules. They don’t have that same feeling for what’s moral, and it’s missing due to impairments in the neural mechanisms underpinning moral judgment.”

Raine has looked beyond the brain in his scrutiny of biology’s connection to crime. Research suggests that there



is a strong genetic basis to criminal behavior. In more than 100 studies of twins, he notes, if one individual in a pair of identical twins is criminal, there is a 50 percent chance that the other will be criminal too. Identical twins have all of their genes in common. Among pairs of fraternal twins, who share only half of their DNA, the chance is cut to 25 percent.

In their own twin study in Los Angeles, Raine and colleagues have been following 600 pairs starting from age nine. They are now 16. He has also carried out a 20-year study of children on Mauritius, a tropical island in the

Indian Ocean. “People who are psychopaths or who have antisocial personality disorder are literally cold-blooded,” he explains. “They have lower heart rates. When they’re stressed, they don’t sweat as much as the rest of us. They don’t have this anticipatory fear that the rest of us have.” This nervousness and fear of being caught and punished helps stop many of us from committing crime, Raine points out. “We’ve got good brakes.”

The Mauritius study measured the biological brakes in nearly 1,800 subjects and found that three-year-old children with poor fear conditioning are much more likely to be criminal offenders by age 23. The research also showed an association of heart rate with aggression. Kids who have a low resting heart rate at age three tend to be more aggressive at age 11.

In yet another study, Raine looked at over 4,000 Copenhagen males who suffered birth complications—forceps delivery, breech birth, lack of oxygen. Infants who experience such difficulties at birth often suffer damage

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to the hippocampus, a part of the brain that regulates aggression. The investigators devised a way to assess maternal rejection in the first year of life and then looked at police records for violence by age 18. The research showed that neither birth complications nor rejection by the mother alone raised the odds of violence. But when both misfortunes fell upon the same individual, there was a threefold increase in the rate of violent crime.

“The message is that it’s not just biology; it’s not just the environment. But when you put the two together, that’s when you get the toxic mix,” asserts Raine, “an explosive increase in violence 18 years later. What I’m intrigued about is how social experiences and social processes can change biology and change behavior.”

Despite the flawed science, Lombroso turned out to be right about his revelation—but only half right. Efforts to understand and deal with crime have long been filtered through the tradition of sociology. But crime, says Raine, is the product not just of economic but neural poverty, not just of dysfunction in society but biochemical misfires in the body. “The harsh reality is we’ve gone decades trying to stop crime. What’s happening? Our prisons are bursting full of prisoners. We’re not doing something right. I think one of the things we’re not doing right is taking enough account of biological and genetic processes in helping us to

understand the causes of crime.”

That’s the challenge for criminologists in the academic pipeline today, says Raine: broken families *and* broken brains. “It’s not biology *versus* environment, he maintains, “it’s biology *plus* environment that give rise to crime.”

The coming generation of criminologists will need to understand both to explain crime and to formulate better prevention and intervention programs.

“The dream has always been to really understand *all* the causes and processes that make up the criminal offender,” he says. “We’re on the threshold of the dream of having a much, much greater understanding of the early routes to crime and violence. Once we know earlier in life who the kids are who really need intervention, that’s when we’ll do a better job stopping future generations of crime.” ♦

IS IT WRONG TO PUNISH PRISONERS? BY ADRIAN RAINE



Is it wrong to punish prisoners? Well, isn't it wrong *not* to punish them? These people know the difference between right and wrong. An eye for an eye, a tooth for a tooth. Shylock in *The Merchant of Venice* took a pound of flesh from Antonio. And rightly so because all successful societies are predicated on the key concepts of justice and responsibility.

But before we plug in the electric chair, let's consider some of the latest neuroscience knowledge on the

brains of psychopaths. When we make a moral decision, a brain area called the amygdala lights up. But in psychopaths, this light that guides conscience and moral behavior has long since gone out.

Now, they didn't ask to be born with the broken amygdalae that pushed them into a criminal career. So what's a good juror to do when faced with criminals with broken brains? Isn't it immoral of us to punish criminals as harshly as we

do? Freedom of will is not as free as you think, and for some the die is cast early in life. Can we in good conscience really blame them?

But at what price mercy? Isn't this argument just a slippery slope to hell, to an irresponsible society and ultimately Armageddon? Mayhap. But consider the point of Portia when she defended Antonio. In her words, “So, good citizens of Locust Walk, though *justice* be thy plea, consider this: that in the course of justice none of us shall see salvation. We do pray for mercy, but that same prayer doth render us all to the deeds of mercy”

So before your finger starts fiddling on that switch on the electric chair, consider one other behavioral response: turn the other cheek. For in the name of neurocriminology it is wrong to punish prisoners.

Adapted from Adrian Raine's 60-Second Lecture, delivered September 10, 2008. To view this and other 60-Second Lectures, visit www.sas.upenn.edu/60secondlectures.