

# THE END OF THE LIE

TWO UNIVERSITY OF PENNSYLVANIA SCIENTISTS HAVE INVENTED MACHINES THAT CAN LOOK INTO YOUR BRAIN AND KNOW WHEN YOU'RE LYING. THE IMPLICATIONS ARE EXTRAORDINARY—AND PRETTY SCARY

**By Matthew Teague**



# M

an has sifted truth and lies, it seems, as long as we've spoken to each other. Eve ate the snake's apple, and we haven't gotten over it since. We're always looking out for that forked tongue.

The spoken word, the shrug, the sideways glance from one person, and then the analysis from the recipient—is there truth here? Or deceit?—all stir deep in our subconscious minds. Even babies, when confused, instinctively search a stranger's face for signals of trust.

But what if some new technology overthrew our ideas of truth and deception? What if we tossed out all our padlocks, and airport metal detectors, and tax auditors? What if—to be clear—what if we killed the lie?

Such a revolution started not long ago. It started on the University of Pennsylvania's campus, in the Anatomy-Chemistry Building, beyond the basement with its spewing liquid nitrogen tanks, in a tiny, windowless room. That's where it sits: one of the most important technological leaps in recent history. A truth machine.

Four subjects—three Pakistanis and I—recently served as human guinea pigs for experiments in the development of the machine. For about a month, the four of us strapped on headbands lined with

infrared light detectors the size of dimes and sat in separate tiny, darkened rooms, in total sensory deprivation except for a single image flashed on a black screen.

There was no electric shock. No flashing light. No gunfire. The revolution started with something quieter, and more powerful.

A simple question: Is this card a spade?

**W**hen I first showed up for experimentation, I followed the security guard's instructions through the basement, down the hall, and across the dirty carpet toward 92-year-old Britton Chance's office. A discarded church pew sat in the hallway, as recycled seating.

Chance and another scientist, Daniel Langleben, have each invented a truth machine and refined them in recent days, and will soon reveal them to the world. The machines work on the same principle: Unlike current so-called "lie detectors," these new machines peer directly into the brain, sorting the gray matter into shades of black and white.

In the hallway, somebody pedaled past on a bicycle with a little squeezable horn on the handlebars. "Wheee!" At

Dr. Chance's office door, the rider climbed off the bike and removed his helmet: the doctor himself.

"Hello, hello," he said, once seated in his office. "I'll be with you in one minute." Drifts of paper covered every level surface in the large space, and various electrical devices sat around half made or unmade. Assistants fluttered at his elbow.

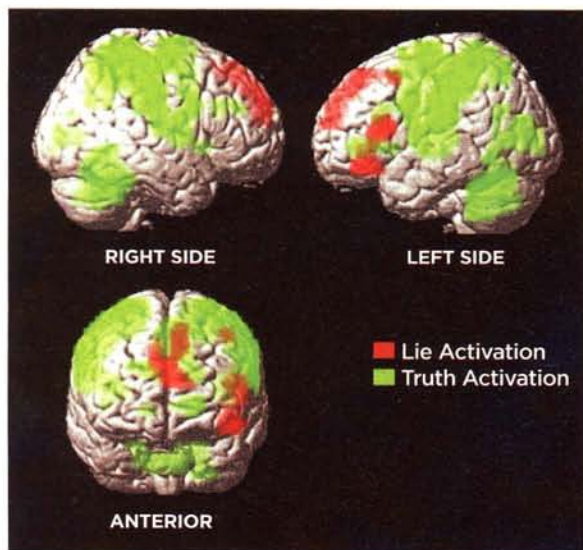
Dr. Chance, now into his 10th decade, moves with the vigor of a younger man, and his face maintains a hawkish quality, always seeking to swoop down and devour knowledge. He seems to have lived the lives of several men; clues lay scattered around his office, in the form of little trinkets and baubles. Some were obvious, like photos of him shaking hands with various presidents. But as I stood waiting for him, other clues began to emerge, to connect, and to hint that Chance had lived the lives not of several ordinary men, but of several *exceptional* men.

He grew up in Philadelphia and became intrigued by science in his childhood, when his father developed a chemical detector that replaced canaries in coal mines. His father also took him sailing off the Atlantic coast, where big ships moved in and out of harbors. Chance noticed that those ships had a difficult and dangerous time steering, so he—a teenager—invented a simple autopilot device with a compass and mirror, then tested it himself aboard the *New Zealand Star*, on a trip from England to Australia.

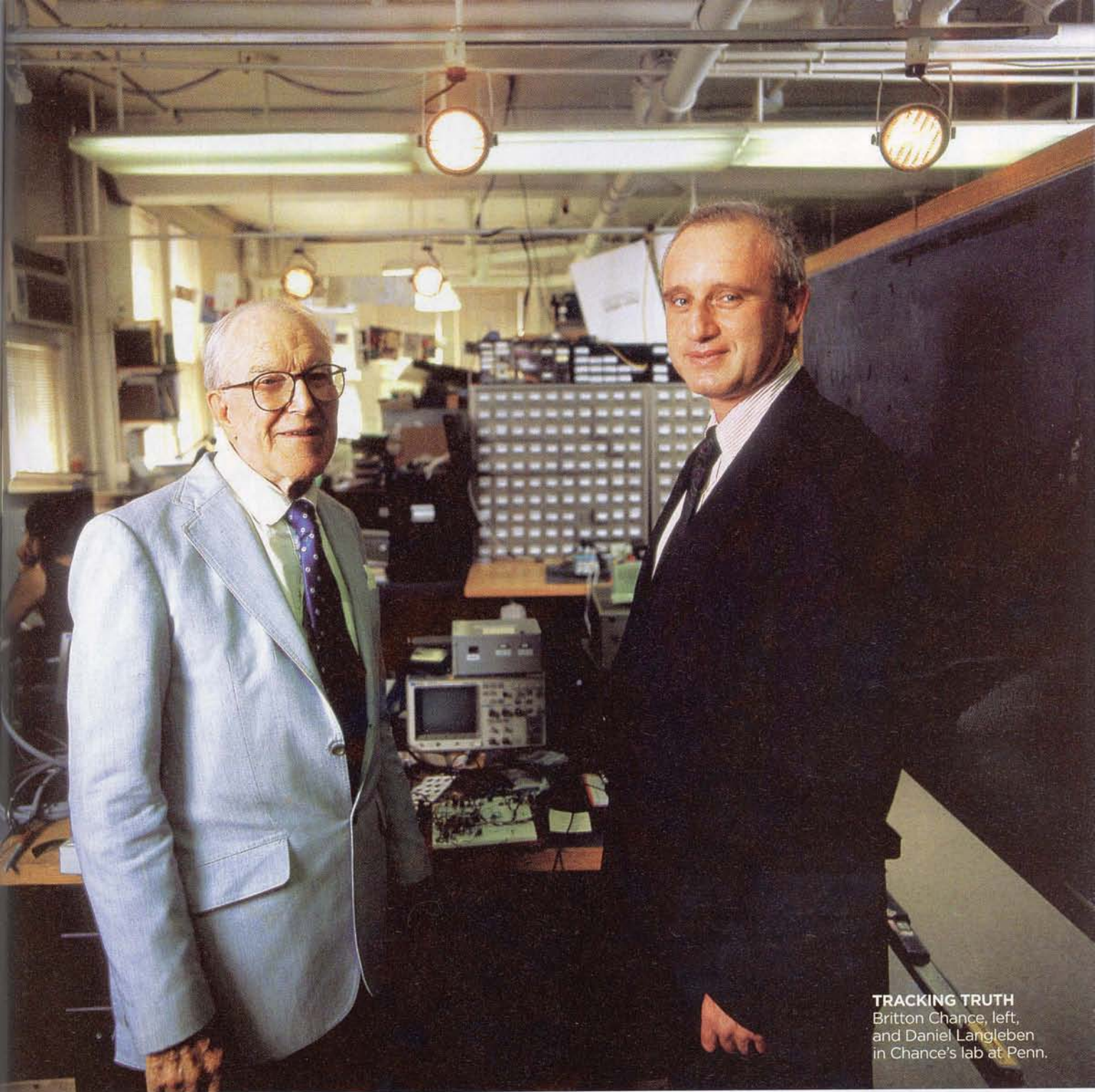
He went on to earn numerous degrees and honors from schools like Cambridge, but Chance's greatest asset—his gift—remained finding simple solutions for complex problems. During the Second World War, for instance, he helped the Allies win by taking two preexisting technologies—radar and bombs—and combining them to create something much more powerful: radar-guided bombs.

At home, he keeps a 450-pound stuffed marlin, a monstrous fish that any sportsman would proudly display. Chance reeled it in during a fishing duel with Ernest Hemingway, off a tropical island. A simple strategy ruled then, too. "He was in the *Pilar*, a big 30- or 40-foot boat," Chance remembered. "We were in a little bait boat, and quick. We took his fish."

In a corner of his office, I saw a faded photo of him as a younger man, in 1952. In it, he stands on an Olympic podium, receiving a gold medal for sailing. "Yes, yes," he said quietly. "I do like sailing." He



**BRAVE NEW WORLD** Telling the truth and lying create different blood flows in the brain.



**TRACKING TRUTH**  
Britton Chance, left,  
and Daniel Langleben  
in Chance's lab at Penn.

later won another medal—the prestigious National Medal of Science—so presumably he likes science, too.

He calls his latest project—his truth machine—the Cognosensor. The machine grew from work he started around 1990, focused on how light and cells interact; his inventions led to advancements ranging from breast cancer detection to muscle dynamics. But his Cognosensor may change the world more than all his other inventions combined.

It looks essentially like a laptop computer attached to a Velcro band, which wraps around the head. “It’s infrared,”

he said. “It projects red light through the skin and the skull and onto the cortex, and some of it comes out again. We measure that.”

Blood, he explained, absorbs more light than the surrounding tissue. When a person fabricates a lie, certain parts of his brain work harder than others, and require more blood. The Cognosensor tracks blood flow, searching for the pattern that indicates “lie” or—remarkably—“malevolent intent,” since both deception and plans to deceive spring from the same part of the brain.

“Homeland security is the name of the

game we play,” he said. “Somebody was going to invent this technology. I figured it’s better us than somebody who wants to use it against us.”

His rationale, I said, seemed awfully similar to the arguments preceding the invention and use of the nuclear bomb. He smiled a thin, sad smile. “This,” he said of his new technology, “*this* is the ultimate weapon.”

It’s simple. Almost frighteningly simple. And the next phase of the Cognosensor’s development, Chance said, is already under (continued on page 165)

## Lie Detector

(continued from page 123)

way: remote sensing. That means that someday in the not-too-distant future, we'll no longer need security searches at the airport, or metal detectors, or bomb-sniffing dogs. We'll simply stroll toward the airplane while a security guard across the terminal aims a penlight at our foreheads, searching for malevolent intent.

If the Cognosensor sounds farfetched, it's not. Chance tested it recently at the Department of Defense with what he called accurate results, but he deferred to the DoD for specific numbers. (The DoD's counterintelligence department declined to address specifics or grant an interview, but noted that the DoD continues "to research new technologies.")

While we talked, Chance wore a shirt embroidered with the acronym DARPA. That's the Defense Advanced Research Projects Agency, a sort of wizards' lair within the Department of Defense where scientists dream up and create new technologies. It has spawned such creations as the Internet, but also other, more controversial offspring—like the Information Awareness Office, a far-reaching government program aimed at achieving "total information awareness"—that critics have decried as frighteningly Orwellian. Chance acknowledged that his Cognosensor does come with some ominous overtones. For instance: For all our love of truth, do we truly want to abolish the lie? "So many crises are avoided by a white lie. Would we really want to change that?" he said. "It's a mess of moral and ethical issues. We must be very careful."

I asked Arthur Caplan, the internationally respected Penn bioethicist, for his opinion on the truth machines. "We're talking about remote observation. It's like the proliferation of the cameras that watch us on the street," he said.

"Only this is inside your head."

I recently met in London with Dr. Richard Wiseman, a British scientist who studies the behavior of lying. He said humans constantly scan each other for signs of deception, looking for subconscious "tells" that betray a fib: a twitchy lip, a hesitant answer, a tapping toe. "Lying is a way of seizing control—that's why we want so badly to detect it," he said. "But we're dreadful at it. We think that if someone won't make eye contact, or they're fidgeting, that they're lying. Actually, those things don't tell us much." So people started looking for better ways to pry the truth from each other.

In ancient India, so the story goes, a priest invented the first recorded lie detector, and maybe the best so far. After a crime in the village, he announced that his magic donkey could determine a man's truthfulness. He led the donkey into a dark room, and sent in the

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# Lie Detector

suspects, with instructions to pull the donkey's tail. The donkey would speak, the priest said, when the dishonest man gave a pull. Each man took a turn, and of course the donkey never spoke. But in preparation, the priest had secretly rubbed lamp soot on the donkey's tail. Afterward, he asked for a show of the suspects' hands: The man with clean hands was pronounced a liar.

The modern magic donkey—the polygraph—arrived in 1935, when a Wisconsin detective contrived a device that measured blood pressure, breathing and sweat. The world embraced it: The military, the FBI, the CIA, and law enforcement agencies everywhere started wiring up subjects and peppering them with questions. The Department of Defense set up a whole Polygraph Institute. The polygraph crept into films and television shows, and into the public consciousness: *the lie detector*.

A few years ago, following allegations of espionage and stolen nuclear secrets, the prestigious National Academy of Sciences started an investigation to answer a simple question: How accurate is the beloved polygraph, really?

Not very, it turns out. Not very at all.

The polygraph isn't a lie detector, for starters. It's an anxiety detector. It measures physiological changes—such as increased heart rate—that we expect from a liar. But if you're an Al Qaeda informer, telling the CIA the truth about your associates might induce more anxiety than lying. Also, NAS pointed out, the polygraph can be duped. Aldrich Ames, a CIA spy and one of the most low-down and ruthless traitors in American history, breezed through routine polygraphs for a decade while he sold out his colleagues to the Soviet Union.

In the end, the NAS determined that the polygraph isn't worthless—it's worse. It hinders the truth. For every spy caught by a determined polygraph tester, according to the study, a whopping *two hundred* innocent subjects would be swept into the net.

The polygraph's only decent use, the NAS concluded, is as a tool of intimidation. A criminal would strive to avoid a polygraph if he thought it worked, and might even confess outright in fear. In other words, the polygraph works in the exact same way as the sooty magic donkey.

What the world needed was a machine that reached beyond the body—beyond the sweat and the quivering voice—and directly into the brain itself. What we needed, in other words, was better magic.

**D**ownstairs, in the testing rooms, I met the other guinea pigs: Maliha Jumani, Fatima Aziz and Hina Batool, three young women from Pakistan.

I asked them how they felt about the Cognosensor and the deception study on which we were embarking. They just blinked. "This is a problem-solving study," Jumani said. "Right?"

I wasn't sure how to respond. Moments before, Chance had offered me a frank indication of how the Cognosensor might be used. "More work needs to be done, obviously a survey of other populations," he said. "Different ethnic groups—is their ethical training such that deceit is a way of life? Someone with a Judeo-Christian background might feel differently about lying than other groups."

The three women were all medical students back in Karachi, at Pakistan's best university. They came to America hoping to study medicine for the summer at an Ivy League school and brighten their résumés. Their other friends, who had been accepted to study at places like Harvard and Yale, were unable to come to the States because their visas had been rejected for security reasons. "We had already decided we wouldn't be able to come, and then we couldn't believe it when our visas came through," Aziz gushed. "We felt so lucky."

The first phase of the experiment did indeed center on problem solving. Chance hypothesized that the "eureka" moment of solving a problem mimics the achievement of telling a lie. So we strapped on our Cognosensors in the tiny, pitch-black testing rooms, and watched white letters flash across a black screen. Our job was to unscramble the letters to form words, in Urdu for the ladies and English for me. It felt like twisting a Rubik's Cube for eight hours a day, and it exhausted each of us. One day, after a severe bout of testing, I pulled the infrared headband off and felt a tingling in my skin. In a bathroom mirror, I found a series of red circles marching across my forehead—minor burns from the infrared light.

After weeks of the anagrams, Chance called us together and announced the true aim of the study: lie detection. The Pakistani ladies sat dumbstruck. Later, Jumani told me she felt tricked. "This isn't medicine," she said. "This is something military."

During the anagram phase, I felt as though the Cognosensor had peeked over my shoulder while I tried to solve a puzzle. But during the lie detection, something else crept in, right away. The first question flashed: Is this card a spade?

Chance had instructed me to lie at some point in the day, whenever I wanted. I decided to start right away. So I lied: Yes, it is a spade. The laptop recorded my brain's activity, tracking the lie as it formed.

Even during that most rudimentary lie, a low-level panic set in, like a slow-motion suffocation. Not because I really cared about the lie, but because the Cognosensor apprehend-

ed it. Of course calculators multiply and divide faster than I can, and a mobile phone can broadcast my voice much farther than I can shout; but for the first time in my life, technology *knew better*. The harder I concentrated, the tighter its grip became. After a while, I learned it felt better to let my brain go idle, relax, and let the lies fly without thought. The Cognosensor had, in a sense, trained me.

Later, when the Pakistani ladies and I compared graphs printed out by the Cognosensor—showing strain in the brain—the charts revealed that lying about card suits had registered a tiny signal; it was a lie so trivial, it could hardly be called deceit. How might the squeezing, suffocating feeling increase, then, when attempting lies that really matter?

**T**here's a second truth machine, just a block or so away from Britton Chance's lab. It's less portable than the infrared headband, but far more advanced.

Its father is Dr. Daniel Langleben, an Israeli immigrant with close-cropped silvering hair. "Sorry I'm behind," he said, bounding into a waiting room at the university's hospital. He wore a backpack and sneakers, and appeared to have jogged the dozen or so blocks from his office. He and Chance work in separate buildings, in separate university departments, but they share ideas and expertise from time to time. After my weeks spent with 92-year-old Chance, meeting 44-year-old Langleben felt like stepping into the path of a galloping colt.

As we walked deeper into the hospital, toward his machine, Langleben talked about lying. He sounded more like a philosopher than a doctor as he noted that people don't even know exactly what it means to lie. "St. Augustine told us everything in his treatise," he said. "We can't improve on it."

That fourth-century treatise is called *De Mendacio*, or *On Lying*. In it, St. Augustine defined the idea: Lying, he said, is a concealment of the truth. That's a simple statement, but scientists like Langleben are only now coming to understand its significance. Since lying is a concealment of the truth, it must rely on the truth in some way. We can't create deception from the air. For instance, a lie:

Grass is blue.

Of course that's untrue. Grass is green. And furthermore, there's no way to tell that particular lie without first thinking of grass's essential greenness.

So: When telling the truth about grass, the brain does one thing. It thinks of green.

But: When lying, it does two. It thinks of green, and then blue. That means something in the brain must suppress the impulse to say "green."

Years ago, Langleben worked with chil-

dren suffering from attention deficit hyperactivity disorder because research had shown that they were terrible liars—they tended to blurt out the truth. Some piece of their brains lacked the ability to suppress it. And it hit him: He could capture the essence of a lie if he could just watch it unfold in the brain. So he developed a technique using functional magnetic resonance imaging, or fMRI, to track the brain's activity.

"Here it is," Langleben said. We had arrived outside the hospital's MRI room. A sign warned that no one with pacemakers or "metallic implants" should venture closer. Inside the room, a patient lay with his head inside the fMRI, which looks like a giant white doughnut. It was a "four tesla" magnet, one of the most powerful magnets in the world. Attendants turned as we walked in: "Shhhhh."

Every atom in creation contains electrical charges—positive for protons, negative for electrons—and the fMRI is so powerful that when someone climbs inside, the machine essentially magnetizes his atoms and causes them to resonate. By manipulating the magnetic field, Langleben can cause different tissues to resonate in their own ways. That makes blood carrying oxygen, for instance, look different from blood without it. So Langleben watches blood flow in much the same way Chance does with his infrared headband, except on a tinier, far more accurate scale.

During his deception study, Langleben handed volunteers a \$20 bill and a playing card, and told them they could keep the cash if they could successfully lie about the card they held. The subjects climbed into the MRI; when their card appeared on a screen, they pressed a button indicating otherwise.

The volunteers' brain-scan images, when combined and viewed together, proved that when we lie, the "truth" part of our brain activates, but so does an additional "suppression" part. The averaged images were interesting on the theoretical level, and grabbed the scientific world's attention. But to make the technology practical, Langleben needed to prove that each individual brain reveals a lie.

Not long ago, Langleben and another scientist, Kosha Ruparel, gathered members of Penn's staff—but not fMRI experts—to "read" the individual brain images by looking at lit-up areas of activity. Of the volunteers' brains, one of the readers correctly identified 25 of 27 liars, with the other readers doing almost as well. That's better than 90 percent accuracy, in the technology's infancy.

Langleben says the fMRI is fully functional—it could be used in basic public applications tomorrow. It's bulky, but Penn has a history of proving that time shrinks all technology: In 1944, the school produced ENIAC, a monstrous machine that consumed an entire city block but whose descendants now sit



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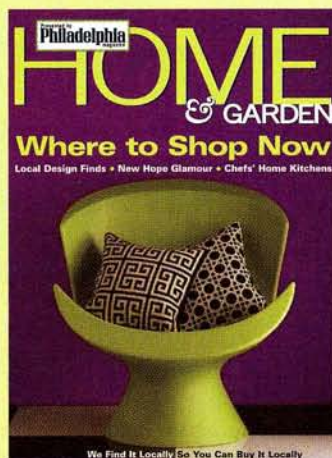


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## Lie Detector

on laps and in pockets around the world. It was the world's first computer.

I asked Langleben why the military hadn't employed his technology at Guantanamo Bay and Abu Ghraib. It might help stave off criticism that the U.S. uses torture to extract information. "I haven't told them about it yet," he said. Instead of working directly for the Pentagon, Langleben planned to publish results of his study in a pair of scientific journals, which is the scientific equivalent of a trumpet herald announcing a new discovery.

Besides: Guantanamo Bay is just the start. The real work awaits in New York, Phoenix, Pottstown, and every other American city and town.

"I expect we'll see parents who maybe find some pot or condoms coming in and saying, 'I want to bring my kid in once a month,'" said Arthur Caplan, the ethicist. He said that other thinkers around the world haven't turned their attention to the truth machines because they simply don't know about them. He does, because the inventors are his colleagues at the university. "Right now, a lot of people are focused on the ethical implications in abortion or genetic advances, like cloning," he said. "But our greatest challenge will come from the neurological sciences. The brain. Because it's where we identify ourselves. It is *us*."

Like the computers that followed ENIAC, the truth machines may improve, and even save, many lives. Caplan said most people might accept their use in airports and rail stations, if they improve security. People might even welcome them.

But some implications, he said, are "appropriately scary."

**T**here are already plans to bring the truth machines into daily American life. Right down into the laptops and bank accounts and sock drawers of average citizens.

"Certain assumptions in ethics are going to be violated," said psychologist Ruben Gur, who helped Langleben devise the fMRI technique. Gur takes ethics seriously, to the point of donating most of his future profits from the truth machine back to the university, for further study. He shook his head. "We want a technology to detect deception," he said. "But at the same time, we're scared of it."

I asked him to name another use for the fMRI, beyond military or covert applications—just an everyday use. "It's going to be a huge industry," he said. "For instance, off the top of my head, I think of dating services." Imagine online dating services where descriptions—single doctor, six-figure income—come stamped with a seal of approv-



al: "Verified by MRI." The very triviality of the idea gives it power. If there's no lying on first dates, there's no lying anywhere.

A company called No Lie MRI, Inc., based in La Jolla, California, leased the rights from Penn to develop the technology for commercial purposes. I spoke with Joel Huizenga, the company's CEO. "Do a little thought experiment. Say there was some murder or robbery," he said. "There's the one person that did it, and then there's the other 20 people who are implicated. There are more people who are innocent, who want to vindicate themselves."

There's a subtle but startling shift there. If, say, there's a town full of people walking around with wristbands that prove they submitted to a truth machine, but one man with a bare wrist, the question becomes: What's he hiding? "Yes. The burden of proof has shifted," Caplan says. "Suddenly it's, 'Prove to me that you're *not* a lying, cheating scumbag.'"

With the added possibility of "remote observation," the world starts to eerily resemble George Orwell's *1984*. Orwell's terms have worn thin from overuse—"Big Brother," for instance—but the idea stands in ever-sharpening relief. In the book, the State imposes conformity on its citizens, dispatching the Thought Police to arrest and torture citizens for "thoughtcrimes."

"If we try to police intentions, it's pretty hard to do, because the lives of most people are filled with bad intentions," Caplan said. "They don't act on them. But I don't want to be questioned every time I have, you know, lust in my heart."

Huizenga argues that the good far outweighs the bad. He gave an example: Insurance companies say 30 percent of payoffs are illegitimate, and so they increase the price of insurance for everyone to cover the deceit. That's where the truth machines step in. "So," he said, "they could give a discount to individuals who are willing to take the truth verification test." He added that once his company finishes collecting initial investors, it plans to open its first facility, in Philadelphia.

Langleben points out that the abolition of the lie doesn't have to come with Orwellian consequences. It could lead to a utopia. "I think there is a tribe in Polynesia where they have no word for 'lie,'" he said. "So theoretically, this kind of society is possible."

I asked Chance: Will the truth machines create a utopia, or Orwell's dystopia? Does the end of the lie mean the end of privacy? And is that good or bad?

He declined to pass judgment, but offered a thoughtful assessment: "This," he said, "is a fearsome thing."

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