

How Technology May Soon "Read" Your Mind

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(CBS) How often have you wondered what your spouse is really thinking? Or your boss? Or the guy sitting across from you on the bus? We all take as a given that we'll never really know for sure. The content of our thoughts is our own - private, secret, and unknowable by anyone else. Until now, that is.

As **correspondent Lesley Stahl** reports, neuroscience research into how we think and what we're thinking is advancing at a stunning rate, making it possible for the first time in human history to peer directly into the brain to read out the physical make-up of our thoughts, some would say to read our minds.

The technology that is transforming what once was science fiction into just plain science is a specialized use of MRI scanning called "functional MRI," fMRI for short. It makes it possible to see what's going on inside the brain while people are thinking.

"You know, every time I walk into that scanner room and I see the person's brain appear on the screen, when I see those patterns, it is just incredible, unthinkable," neuroscientist Marcel Just told Stahl.

He calls it "thought identification."

Whatever you want to call it, what Just and his colleague Tom Mitchell at Carnegie Mellon University have done is combine fMRI's ability to look at the brain in action with computer science's new power to sort through massive amounts of data. The goal: to see if they could identify exactly what happens in the brain when people think specific thoughts.

They did an experiment where they asked subjects to think about ten objects - five of them tools like screwdriver and hammer, and five of them dwellings, like igloo and castle. They then recorded and analyzed the activity in the subjects' brains for each.

"The computer found the place in the brain where that person was thinking 'screwdriver'?" Stahl asked.

"Screwdriver isn't one place in the brain. It's many places in the brain. When you think of a screwdriver, you think about how you hold it, how you twist it, what it looks like, what you use it for," Just explained.

He told Stahl each of those functions are in different places.

When we think "screwdriver" or "igloo" for example, Just says neurons start firing at varying levels of intensity in different areas throughout the brain. "And we found that we could identify which object they were thinking about from their brain activation patterns," he said.

"We're identifying the thought that's occurring. It's...incredible, just incredible," he added.

"Are you saying that if you think of a hammer, that your brain is identical to my brain when I think of a hammer?" Stahl asked.

"Not identical. We have idiosyncrasies. Maybe I've had a bad experience with a hammer and you haven't, but it's close enough to identify each other's thoughts. So, you know, that was never known before," Just explained.

60 Minutes asked if his team was up for a challenge: would they take associate producer Meghan Frank, whose brain had never been scanned before, and see if the computer could identify her thoughts? Just and Mitchell agreed to give it a try and see if they could do it in almost real time.

Just said nobody had ever done an instant analysis like this.

Inside the scanner, Meghan was shown a series of ten items and asked to think for a few seconds about each one.

"If it all comes out right, when she's thinking 'hammer,' the computer will know she's thinking 'hammer'?" Stahl asked.

"Right," Mitchell replied.

Within minutes, the computer, unaware of what pictures Meghan had been shown and working only from her brain activity patterns as read out by the scanner, was ready to tell us, in its own voice, what it believed was the first object Meghan had been thinking about.

The computer correctly analyzed the first three words - knife, hammer, and window, and aced the rest as well.

According to Just, this is just the beginning.

"Who knows what you're gonna be able to read," Stahl commented. "A little scary, actually."

"Well, that's our research program for the next five years," Just said. "To see what, you know - we're not satisfied with 'hammer.'"

And neither are neuroscientists 4,000 miles away in Berlin at the Bernstein Center. John Dylan-Haynes is hard at work there using the scanner not just to identify objects people are thinking about, but to read their intentions.

Subjects were asked to make a simple decision - whether to add or subtract two numbers they would be shown later on. Haynes found he could read directly from the activity in a small part of the brain that controls intentions what they had decided to do.

"This is a kind of blown up version of the brain activity happening here. And you can see that if a person is planning to add or to subtract, the pattern of brain activity is different in these two cases," Haynes explained.

"I always tell my students that there is no science fiction anymore. All the science fiction I read in high school, we're doing," Paul Root Wolpe, director of the Center for Ethics at Emory University in Atlanta, told Stahl.

To Wolpe, the ability to read our thoughts and intentions this way is revolutionary. "Throughout history, we could never actually coerce someone to reveal information. Torture doesn't work that well, persuasion doesn't work that well. The right to keep one's thoughts locked up in their brain is amongst the most fundamental rights of being human."

"You're saying that if someone can read my intentions, we have to talk about who might in the future be able to do that?" Stahl asked.

"Absolutely," he replied. "Whether we're going to let the state do it or whether we're going to let me do it. I have two teenage daughters. I come home one day and my car is dented and both of them say they didn't do it. Am I going to be allowed to drag them off to the local brain imaging lie detection company and get them put in a scanner? We don't know."

But before we've even started the debate, there are two companies already offering lie detection services using brain scans, one with the catchy name "No Lie MRI." But our experts cautioned that the technique is still unproven.

In the meantime, Haynes is working on something he thinks may be even more effective: reading out from your brain exactly where you've been. Haynes showed Stahl an experiment he created out of a video game.

He had Stahl navigate through a series of rooms in different virtual reality houses.

"Now I would put you in a scanner and I would show you some of these scenes that you've seen and some scenes that you haven't seen," he told her.

Stahl recognized the bar. "And right at this moment, we would be able to tell from your brain activity that you've already seen this environment before," Haynes explained.

"And so, this is a potential tool...for the police...in the case of break-ins?" Stahl asked.

"You might be able to tell if someone's been in an al Qaeda training camp before," Haynes replied.

Haynes said while U.S. national security agencies had not been in touch with him, the Germans had.

"So there are people who are considering these kinds of possibilities," Stahl commented.

And some are using them. In India last summer, a woman was convicted of murder after an EEG of her brain allegedly revealed that she was familiar with the circumstances surrounding the poisoning of her ex-fiancé.

"Can you through our legal system be forced to take one of these tests?" Stahl asked Paul Root Wolpe.

"It's a great question. And the legal system hasn't decided on this yet," he said.

"But we do have a Fifth Amendment. We don't have to incriminate ourselves," Stahl pointed out.

"Well here's where it gets very interesting, because the Fifth Amendment only prevents the courts from forcing us to testify against ourselves. But you can force me to give DNA or a hair sample or blood even if that would incriminate me. So here's the million dollar question: if you can brain image me and get information directly from my brain, is that testimony? Or is that like DNA, blood, semen and other things that you could take from me?" Wolpe asked.

"There will be a Supreme Court case about this," he predicted.

For now, it's impossible to force someone to have his or her brain scanned, because the subject has to lie still and cooperate, but that could change.

"There are some other technologies that are being developed that may be able to be used covertly and even remotely. So, for example, they're trying to develop now a beam of light that would be projected onto your forehead. It would go a couple of millimeters into your frontal cortex, and then receptors would get the reflection of that light. And there's some studies that suggest that we could use that as a lie detection device," Wolpe said.

He said we wouldn't know if our brains were being scanned. "If you were sitting there in the airport and being questioned, they could beam that on your forehead without your knowledge. We can't do that yet, but they're working on it."

Scary as that is, imagine a world where companies could read our minds too.

Light beams may be a bit far off, but fMRI scanning is already being used to try to figure out what we want to buy and how to sell it to us. It's a new field called "neuromarketing." One of its pioneers is neuroscientist Gemma Calvert, co-founder of a London company called Neurosense.

Asked if she has a lot of clients, Calvert told Stahl, "Yes, such as Unilever, Intel, McDonald's, Proctor & Gamble, MTV or Viacom."

And she says it's a growing field. "What we've seen is a sort of snowballing effect over the last few years. I think there are about 92 neuromarketing agencies worldwide."

But some experts question whether it's ethical to scan the brain for commercial purposes, and say neuromarketers may be promising more than they can really deliver.

"If you image my brain, and you say, 'Ah-ha! Paul craves chocolate chip cookies,' and I say, 'No, I don't,' now are you going to believe the brain over me? You can only do that if you have proven that that part of the brain lighting up means in all cases that that person desires chocolate chip cookies. And what a lot of people are doing is they're just imaging the brain, and then they're declaring what that means, and they're never proving that it actually translates into behavior," Wolpe said.

"You know it's very interesting. When you show someone a brain scan, people just believe it. It just reeks of credibility," Stahl commented.

"Absolutely. Absolutely," John Dylan-Haynes agreed.

"And you telling me, 'That's the area where people add and subtract,' I thought, 'Well, of course. He knows,'" Stahl said.

"But I could have told you anything," he pointed out.

So as brain imaging continues to advance and find its way into the courts, the market, and who knows what other aspects of our lives, one message is: be cautious. Another is to get ready. Back at Carnegie Mellon, Just and Mitchell have already uncovered the signatures in our brains for kindness, hypocrisy, and love.

"It's breathtaking," Stahl said. "And kind of eerie."

"Well, you know, I think the reason people have that reaction is because it reveals the essence of what it means to be a person. All of those kinds of things that define us as human beings are brain patterns," Just replied.

"We don't wanna know that... it all boils down to, I don't know, molecules and things like that," Stahl said.

"But we are, you know, we are biological creatures. You know, our limbs we accept are, you know, muscles and bone. And our brain is a

biological thinking machine," he replied.

"Do you think one day, who knows how far into the future, there'll be a machine that'll be able to read very complex thought like 'I hate so-and-so'? Or you know, 'I love the ballet because...?'" Stahl asked.

"Definitely. Definitely," Just said. "And not in 20 years. I think in three, five years."

"In three years?" Stahl asked.

"Well, five," Just replied with a smile.

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