Science & Technology

Known Unknowns

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|
Spring 2012

It had the look of a trial. And to Mark Churchland, an assistant professor in the neuroscience department, it probably felt like one.

Behind a small wooden table at the front of Hamilton 717, Churchland sat with the chairman of the biological-sciences department, Stuart Firestein, facing a lecture hall full of students eager to quiz Churchland on what he didn't know. It was the second meeting of Ignorance, a class that invites researchers to publicly expose the gaps in their knowledge. All in the name of science.

The idea for the class, now in its sixth year, came to Firestein while he was teaching Neurobiology I: Cellular and Molecular Neurobiology, "a big, tough class with a big textbook of 1,400 pages that weighs 7.7 pounds," Firestein says. "I came to realize that I was giving the kids the idea that we know everything there is to know in neuroscience. So I thought maybe I should tell them more about what we don't know, which is really more interesting."

Curiosity, not certainty, inspires progress, as Firestein writes in his forthcoming book, *Ignorance: How It Drives Science*: "The undone part of science that gets us into the lab early and keeps us there late, the thing that turns your crank, the very driving force of science, the exhilaration of the unknown — all that is missing from our classrooms."

In Hamilton 717, Churchland eased into the two-hour discussion by explaining some things he *did* know. "Take Larry Bird," he said, referring to the former NBA star. In 1989 and 1990, Bird "had the longest streak of free throws. Seventy-one free throws. Generally considered a remarkable feat. You might want to ask yourself, 'Why didn't he hit seventy-two?'"

As a neuroscientist who specializes in the motor cortex — the region of the brain that controls body movements — Churchland is obsessed with such questions. A robot could be programmed to throw the ball in the hoop every single time, he said, and Larry Bird had successfully made that same shot thousands of times. So what went wrong?

To study this problem of inconsistency, Churchland taught monkeys in a lab to point at an object on a screen. (They were rewarded with juice.) He then attached electrodes to their heads, prompted them to point to the object, and monitored the signal that traveled from their brains to their muscles. He discovered that the monkeys picked up the movements easily, but no matter how much they practiced, there were still variables in how the signal traveled, producing inconsistent results.

Churchland's conclusion? "We're built to be really good at making motor plans on the fly for situations we've never encountered before," he said. "You've never stood on that exact rock throwing a spear of that exact weight at that particular mammoth running in that direction. And yet, you can come up with a pretty good plan for doing that." But you can't hit the mammoth in the same spot with the same force every time. Or hit every free throw. "We sacrifice reliability for flexibility," he said.

What Churchland doesn't know is why.

Firestein, leaning back in his chair, arms crossed and eyes fixed on Churchland, began the questioning. Are there any ways in which animals benefit from this variability?

"For Tiger Woods, it's always bad," said Churchland, because the golfer can't re-create his perfect swing every time. But there is a species of songbird, one that has a region of the brain dedicated to variability, in which males can generate an endless supply of new melodies to attract females. "So sometimes variability is good, because it allows you to find a solution that you didn't know was there before."

"Are there any neural differences between genders?" said a man in the audience wearing thick-rimmed glasses.

"We train male and female monkeys to reach," said Churchland. "It's all the same. But we prefer male monkeys because they're thirstier." (In other words, they work harder for the juice reward.) He conceded, however, that there were probably some neural differences between genders, “but I don’t know what.”

A curly-haired student in a blue T-shirt asked if there had been any research tying motor activity to memory. “I ask because I was taught that musical improvisation isn’t really improvisation,” he said, “but is just drawing on what you’ve done before.”

“There’s a lot about music I don’t know,” said Churchland, who then noted that it takes longer to execute most motor activities than to plan them. “I can take five seconds to gather my thoughts and utter a sentence that lasts twenty seconds,” he said.

At 8 p.m., the class applauded and filed out of the room. Some people were left scratching their heads.

“I’m just realizing how much I really don’t know,” said Issa Mase, a sophomore. “You’re talking to someone who’s a leader in his field talking about what he doesn’t know, and it’s just like, ‘Wow, I’ve got a long way to go.’”

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