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SCIENCE

Our Microbiome May Be Looking Out for Itself

Carl Zimmer

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Your body is home to about 100 trillion bacteria and other microbes, collectively known as your microbiome. Naturalists first became aware of our invisible lodgers in the 1600s, but it wasn't until the past few years that we've become really familiar with them.

This recent research has given the microbiome a cuddly kind of fame. We've come to appreciate how beneficial our microbes are — breaking down our food, fighting off infections and nurturing our immune system. It's a lovely, invisible garden we should be tending for our own well-being.

But in the journal Bioessays, a team of scientists has raised a creepier possibility. Perhaps our menagerie of germs is also influencing our behavior in order to advance its own evolutionary success — giving us cravings for certain foods, for example.

Maybe the microbiome is our puppet master.

"One of the ways we started thinking about this was in a crime-novel perspective," said Carlo C. Maley, an evolutionary biologist at the University of California, San Francisco, and a co-author of the new paper. "What are the

means, motives and opportunity for the microbes to manipulate us? They have all three."

The idea that a simple organism could control a complex animal may sound like science fiction. In fact, there are many well-documented examples of parasites controlling their hosts.

Some species of fungi, for example, infiltrate the brains of ants and coax them to climb plants and clamp onto the underside of leaves. The fungi then sprout out of the ants and send spores showering onto uninfected ants below.

How parasites control their hosts remains mysterious. But it looks as if they release molecules that directly or indirectly can influence their brains.

Our microbiome has the biochemical potential to do the same thing. In our guts, bacteria make some of the same chemicals that our neurons use to communicate with one another, such as dopamine and serotonin. And the microbes can deliver these neurological molecules to the dense web of nerve endings that line the gastrointestinal tract.

A number of recent studies have shown that gut bacteria can use these signals to alter the biochemistry of the brain. Compared with ordinary mice, those raised free of germs behave differently in a number of ways. They are more anxious, for example, and have impaired memory.

Adding certain species of bacteria to a normal mouse's microbiome can reveal other ways in which they can influence behavior. Some bacteria lower stress levels in the mouse. When scientists sever the nerve relaying signals from the gut to the brain, this stress-reducing effect disappears.

Some experiments suggest that bacteria also can influence the way their hosts eat. Germ-free mice develop more receptors for sweet flavors in their intestines, for example. They also prefer to drink sweeter drinks than normal mice do.

Scientists have also found that bacteria can alter levels of hormones that govern appetite in mice.

Dr. Maley and his colleagues argue that our eating habits create a strong motive for microbes to manipulate us. “From the microbe’s perspective, what we eat is a matter of life and death,” Dr. Maley said.

Different species of microbes thrive on different kinds of food. If they can prompt us to eat more of the food they depend on, they can multiply.

Microbial manipulations might fill in some of the puzzling holes in our understandings about food cravings, Dr. Maley said. Scientists have tried to explain food cravings as the body’s way to build up a supply of nutrients after deprivation, or as addictions, much like those for drugs like tobacco and cocaine.

But both explanations fall short. Take chocolate: Many people crave it fiercely, but it isn’t an essential nutrient. And chocolate doesn’t drive people to increase their dose to get the same high. “You don’t need more chocolate at every sitting to enjoy it,” Dr. Maley said.

Perhaps, he suggests, the certain kinds of bacteria that thrive on chocolate are coaxing us to feed them.

John F. Cryan, a neuroscientist at University College Cork in Ireland who was not involved in the new study, suggested that microbes might also manipulate us in ways that benefited both them and us. “It’s probably not a simple parasitic scenario,” he said.

Research by Dr. Cryan and others suggests that a healthy microbiome helps mammals develop socially. Germ-free mice, for example, tend to avoid contact with other mice.

That social bonding is good for the mammals. But it may also be good for the bacteria.

"When mammals are in social groups, they're more likely to pass on microbes from one to the other," Dr. Cryan said.

"I think it's a very interesting and compelling idea," said Rob Knight, a microbiologist at the University of Colorado, who was also not involved in the new study.

If microbes do in fact manipulate us, Dr. Knight said, we might be able to manipulate them for our own benefit — for example, by eating yogurt laced with bacteria that would make us crave healthy foods.

"It would obviously be of tremendous practical importance," Dr. Knight said. But he warned that research on the microbiome's effects on behavior was "still in its early stages."

The most important thing to do now, Dr. Knight and other scientists said, was to run experiments to see if microbes really are manipulating us.

Mark Lyte, a microbiologist at the Texas Tech University Health Sciences Center who pioneered this line of research in the 1990s, is now conducting some of those experiments. He's investigating whether particular species of bacteria can change the preferences mice have for certain foods.

"This is not a for-sure thing," Dr. Lyte said. "It needs scientific, hard-core demonstration."

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