How Your Cat Is Making You Crazy

JAROSLAV FLEGR IS NO KOOK. AND YET, FOR YEARS, HE SUSPECTED HIS MIND HAD BEEN TAKEN OVER BY PARASITES THAT HAD INVADED HIS BRAIN. SO THE PROLIFIC BIOLOGIST TOOK HIS SCIENCE-FICTION HUNCH INTO THE LAB. WHAT HE'S NOW DISCOVERING WILL STARTLE YOU. COULD TINY ORGANISMS CARRIED BY HOUSE CATS BE CREEPING INTO OUR BRAINS, CAUSING EVERYTHING FROM CAR WRECKS TO SCHIZOPHRENIA?

By Kathleen McAuliffe

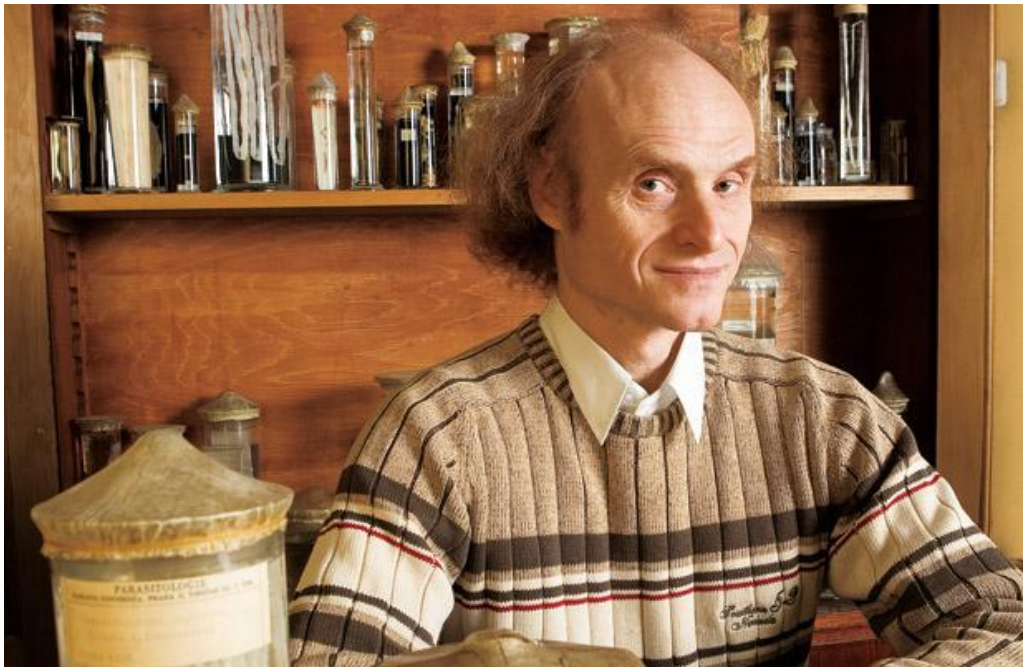


Image credit: Michal Novotný

NO ONE WOULD accuse Jaroslav Flegr of being a conformist. A self-described "sloppy dresser," the 53-year-old Czech scientist has the contemplative air of someone habitually lost in thought, and his still-youthful, square-jawed face is framed by frizzy red hair that encircles his head like a ring of fire.

Certainly Flegr's thinking is jarringly unconventional. Starting in the early 1990s, he began to suspect that a single-celled parasite in the protozoan family was subtly manipulating his personality, causing him to behave in strange, often self-destructive ways. And if it was messing with his mind, he reasoned, it was probably doing the same to others.

The parasite, which is excreted by cats in their feces, is called *Toxoplasma gondii* (*T. gondii* or *Toxo*

for short) and is the microbe that causes toxoplasmosis—the reason pregnant women are told to avoid cats' litter boxes. Since the 1920s, doctors have recognized that a woman who becomes infected during pregnancy can transmit the disease to the fetus, in some cases resulting in severe brain damage or death. *T. gondii* is also a major threat to people with weakened immunity: in the early days of the AIDS epidemic, before good antiretroviral drugs were developed, it was to blame for the dementia that afflicted many patients at the disease's end stage. Healthy children and adults, however, usually experience nothing worse than brief flu-like symptoms before quickly fighting off the protozoan, which thereafter lies dormant inside brain cells—or at least that's the standard medical wisdom.

But if Flegr is right, the "latent" parasite may be quietly tweaking the connections between our neurons, changing our response to frightening situations, our trust in others, how outgoing we are, and even our preference for certain scents. And that's not all. He also believes that the organism contributes to car crashes, suicides, and mental disorders such as schizophrenia. When you add up all the different ways it can harm us, says Flegr, "*Toxoplasma* might even kill as many people as malaria, or at least a million people a year."

An evolutionary biologist at Charles University in Prague, Flegr has pursued this theory for decades in relative obscurity. Because he struggles with English and is not much of a conversationalist even in his native tongue, he rarely travels to scientific conferences. That "may be one of the reasons my theory is not better known," he says. And, he believes, his views may invite deep-seated opposition. "There is strong psychological resistance to the possibility that human behavior can be influenced by some stupid parasite," he says. "Nobody likes to feel like a puppet. Reviewers [of my scientific papers] may have been offended." Another more obvious reason for resistance, of course, is that Flegr's notions sound an awful lot like fringe science, right up there with UFO sightings and claims of dolphins telepathically communicating with humans.

But after years of being ignored or discounted, Flegr is starting to gain respectability. Psychedelic as his claims may sound, many researchers, including such big names in neuroscience as Stanford's Robert Sapolsky, think he could well be onto something. Flegr's "studies are well conducted, and I can see no reason to doubt them," Sapolsky tells me. Indeed, recent findings from Sapolsky's lab and British groups suggest that the parasite is capable of extraordinary shenanigans. *T. gondii*, reports Sapolsky, can turn a rat's strong innate aversion to cats into an attraction, luring it into the jaws of its No. 1 predator. Even more amazing is how it does this: the organism rewires circuits in parts of the brain that deal with such primal emotions as fear, anxiety, and sexual arousal. "Overall," says Sapolsky, "this is wild, bizarre neurobiology." Another academic heavyweight who takes Flegr seriously is the schizophrenia expert E. Fuller Torrey, director of the Stanley Medical Research Institute, in Maryland. "I admire Jaroslav for doing [this research]," he says. "It's obviously not politically correct, in the sense that not many labs are doing it. He's done it mostly on his own, with very little support. I think it bears looking at. I find it completely credible."

What's more, many experts think *T. gondii* may be far from the only microscopic puppeteer capable of pulling our strings. "My guess is that there are scads more examples of this going on in mammals, with parasites we've never even heard of," says Sapolsky.

Familiar to most of us, of course, is the rabies virus. On the verge of killing a dog, bat, or other warm-blooded host, it stirs the animal into a rage while simultaneously migrating from the nervous system to the creature's saliva, ensuring that when the host bites, the virus will live on in a new carrier. But aside from rabies, stories of parasites commandeering the behavior of large-brained mammals are rare. The far more common victims of parasitic mind control—at least the ones we know about—are fish, crustaceans, and legions of insects, according to Janice Moore, a behavioral biologist at Colorado State University. "Flies, ants, caterpillars, wasps, you name it—there are truckloads of them behaving weirdly as a result of parasites," she says.

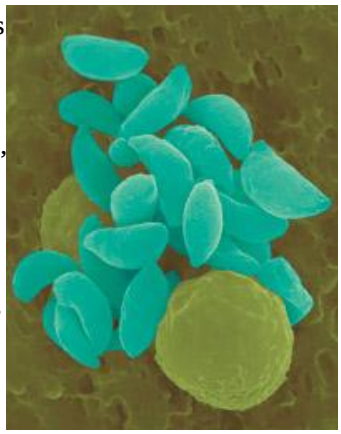
Consider *Polysphincta gutfreundi*, a parasitic wasp that grabs hold of an orb spider and attaches a tiny egg to its belly. A wormlike larva emerges from the egg, and then releases chemicals that prompt the spider to abandon weaving its familiar spiral web and instead spin its silk thread into a special pattern that will hold the cocoon in which the larva matures. The "possessed" spider even crochets a specific geometric design in the net, camouflaging the cocoon from the wasp's predators.

Flegr himself traces his life's work to another master of mind control. Almost 30 years ago, as he was reading a book by the British evolutionary biologist Richard Dawkins, Flegr was captivated by a passage describing how a flatworm turns an ant into its slave by invading the ant's nervous system. A drop in temperature normally causes ants to head underground, but the infected insect instead climbs to the top of a blade of grass and clamps down on it, becoming easy prey for a grazing sheep. "Its mandibles actually become locked in that position, so there's nothing the ant can do except hang there in the air," says Flegr. The sheep grazes on the grass and eats the ant; the worm gains entrance into the ungulate's gut, which is exactly where it needs to be in order to complete—as the *Lion King* song goes—the circle of life. "It was the first I learned about this kind of manipulation, so it made a big impression on me," Flegr says.

After he read the book, Flegr began to make a connection that, he readily admits, others might find crazy: his behavior, he noticed, shared similarities with that of the reckless ant. For example, he says, he thought nothing of crossing the street in the middle of dense traffic, "and if cars honked at me, I didn't jump out of the way." He also made no effort to hide his scorn for the Communists who ruled Czechoslovakia for most of his early adulthood. "It was very risky to openly speak your mind at that time," he says. "I was lucky I wasn't imprisoned." And during a research stint in eastern Turkey, when the strife-torn region frequently erupted in gunfire, he recalls being "very calm." In contrast, he says, "my colleagues were terrified. I wondered what was wrong with myself."

His bewilderment continued until 1990, when he joined the biology faculty of Charles University. As it happened, the 650-year-old institution had long been a world leader in documenting the health effects of *T. gondii*, as well as developing methods for detecting the parasite. In fact, just as Flegr was arriving, his colleagues were searching for infected individuals on whom to test their improved diagnostic kits, which is how he came to be asked one day to roll up his sleeve and donate blood. He discovered that he had the parasite—and just possibly, he thought, the key to his baffling self-destructive streak.

He delved into *T. gondii*'s life cycle. After an infected cat defecates, Flegr learned, the parasite is typically picked up from the soil by scavenging or grazing animals—notably rodents, pigs, and cattle—all of which then harbor it in their brain and other body tissues. Humans, on the other hand, are exposed not only by coming into contact with litter boxes, but also, he found, by drinking water contaminated with cat feces, eating unwashed vegetables, or, especially in Europe, by consuming raw or undercooked meat. Hence the French, according to Flegr, with their love of steak prepared *saignant*—literally, "bleeding"—can have infection rates as high as 55 percent. (Americans will be happy to hear that the parasite resides in far fewer of them, though a still substantial portion: 10 to 20 percent.) Once inside an animal or human host, the parasite then needs to get back into the cat, the only place where it can sexually reproduce—and this is when, Flegr believed, behavioral manipulation might come into play.



The parasite T. gondii, *seen here, may be changing connections between our neurones, altering how we act and feel. (Dennis Kunkel Microscropy, Inc./Visuals Unlimited/Corbis Images)*

Researchers had already observed a few peculiarities about rodents with *T. gondii* that bolstered Flegr's theory. The infected rodents were much more active in running wheels than uninfected rodents were, suggesting that they would be more-attractive targets for cats, which are drawn to fast-moving objects. They also were less wary of predators in exposed spaces. Little, however, was known about how the latent infection might influence humans, because we and other large mammals were widely presumed to be accidental hosts, or, as scientists are fond of putting it, a "dead end" for the parasite. But even if we were never part of the parasite's life cycle, Flegr reasoned, mammals from mouse to man share the vast majority of their genes, so we might, in a case of mistaken identity, still be vulnerable to manipulations by the parasite.

In the Soviet-stunted economy, animal studies were way beyond Flegr's research budget. But fortunately for him, 30 to 40 percent of Czechs had the latent form of the disease, so plenty of students were available "to serve as very cheap experimental animals." He began by giving them and their parasite-free peers standardized personality tests—an inexpensive, if somewhat crude, method of measuring differences between the groups. In addition, he used a computer-based test to assess the reaction times of participants, who were instructed to press a button as soon as a white square popped up anywhere against the dark background of the monitor.

The subjects who tested positive for the parasite had significantly delayed reaction times. Flegr was especially surprised to learn, though, that the protozoan appeared to cause many sex-specific changes in personality. Compared with uninfected men, males who had the parasite were more introverted, suspicious, oblivious to other people's opinions of them, and inclined to disregard rules. Infected women, on the other hand, presented in exactly the opposite way: they were more outgoing, trusting, image-conscious, and rule-abiding than uninfected women.

The findings were so bizarre that Flegr initially assumed his data must be flawed. So he tested other groups—civilian and military populations. Again, the same results. Then, in search of more corroborating evidence, he brought subjects in for further observation and a battery of tests, in which they were rated by someone ignorant of their infection status. To assess whether participants valued the opinions of others, the rater judged how well dressed they appeared to be. As a measure of gregariousness, participants were asked about the number of friends they'd interacted with over the past two weeks. To test whether they were prone to being suspicious, they were asked, among other things, to drink an unidentified liquid.

The results meshed well with the questionnaire findings. Compared with uninfected people of the same sex, infected men were more likely to wear rumpled old clothes; infected women tended to be more meticulously attired, many showing up for the study in expensive, designer-brand clothing. Infected men tended to have fewer friends, while infected women tended to have more. And when it came to downing the mystery fluid, reports Flegr, "the infected males were much more hesitant than uninfected men. They wanted to know why they had to do it. Would it harm them?" In contrast, the infected women were the most trusting of all subjects. "They just did what they were told," he says.

Why men and women reacted so differently to the parasite still mystified him. After consulting the psychological literature, he started to suspect that heightened anxiety might be the common denominator underlying their responses. When under emotional strain, he read, women seek solace through social bonding and nurturing. In the lingo of psychologists, they're inclined to "tend and befriend." Anxious men, on the other hand, typically respond by withdrawing and becoming hostile or

antisocial. Perhaps he was looking at flip sides of the same coin.

Closer inspection of Flegr's reaction-time results revealed that infected subjects became less attentive and slowed down a minute or so into the test. This suggested to him that *Toxoplasma* might have an adverse impact on driving, where constant vigilance and fast reflexes are critical. He launched two major epidemiological studies in the Czech Republic, one of men and women in the general population and another of mostly male drivers in the military. Those who tested positive for the parasite, both studies showed, were about two and a half times as likely to be in a traffic accident as their uninfected peers.

WHEN I MET Flegr for the first time, last September, at his office on the third floor of Charles University's Biological Sciences building, I was expecting something of a wild man. But once you get past the riotous red hair, his style is understated. Thin and slight of build, he's soft-spoken, precise with his facts, and—true to his *Toxo* status—clad in old sneakers, faded bell-bottom jeans, and a loose-fitting button-up shirt. As our conversation proceeds, I discover that his latest findings have become—to quote *Alice in Wonderland*—"curiouser and curiouser," which may explain why his forehead has the deep ruts of a chronic worrier, or someone perpetually perplexed.

He's published some data, he tells me, that suggest infected males might have elevated testosterone levels. Possibly for that reason, women shown photos of these men rate them as more masculine than pictures of uninfected men. "I want to investigate this more closely to see if it's true," he says. "Also, it could be women find infected men more attractive. That's something else we hope to test."

Meanwhile, two Turkish studies have replicated his studies linking *Toxoplasma* to traffic accidents. With up to one-third of the world infected with the parasite, Flegr now calculates that *T. gondii* is a likely factor in several hundred thousand road deaths each year. In addition, reanalysis of his personality-questionnaire data revealed that, just like him, many other people who have the latent infection feel intrepid in dangerous situations. "Maybe," he says, "that's another reason they get into traffic accidents. They don't have a normal fear response."

It's almost impossible to hear about Flegr's research without wondering whether you're infected—especially if, like me, you're a cat owner, favor very rare meat, and identify even a little bit with your *Toxo* sex stereotype. So before coming to Prague, I'd gotten tested for the parasite, but I didn't yet know the results. It seemed a good time to see what his intuition would tell me. "Can you guess from observing someone whether they have the parasite—myself, for example?," I ask.

"No," he says, "the parasite's effects on personality are very subtle." If, as a woman, you were introverted before being infected, he says, the parasite won't turn you into a raving extrovert. It might just make you a little less introverted. "I'm very typical of *Toxoplasma* males," he continues. "But I don't know whether my personality traits have anything to do with the infection. It's impossible to say for any one individual. You usually need about 50 people who are infected and 50 who are not, in order to see a statistically significant difference. The vast majority of people will have no idea they're infected."

Still, he concedes, the parasite could be very bad news for a small percentage of people—and not just those who might be at greater risk for car accidents. Many schizophrenia patients show shrinkage in parts of their cerebral cortex, and Flegr thinks the protozoan may be to blame for that. He hands me a recently published paper on the topic that he co-authored with colleagues at Charles University, including a psychiatrist named Jiri Horacek. Twelve of 44 schizophrenia patients who underwent MRI scans, the team found, had reduced gray matter in the brain—and the decrease occurred almost exclusively in those who tested positive for *T. gondii*. After reading the abstract, I must look stunned, because Flegr smiles and says, "Jiri had the same response. I don't think he believed it could be true." When I later speak with Horacek, he admits to having been skeptical about Flegr's theory at the outset.

When they merged the MRI results with the infection data, however, he went from being a doubter to being a believer. “I was amazed at how pronounced the effect was,” he says. “To me that suggests the parasite may trigger schizophrenia in genetically susceptible people.”

One might be tempted to dismiss the bulk of Flegr’s work as hokum—the fanciful imaginings of a lone, eccentric scholar—were it not for the pioneering research of Joanne Webster, a parasitologist at Imperial College London. Just as Flegr was embarking on his human trials, Webster, then a freshly minted Ph.D., was launching studies of *Toxo*-infected rodents, reasoning, just as Flegr did, that as hosts of the parasite, they would be likely targets for behavioral manipulation.

She quickly confirmed, as previous researchers had shown, that infected rats were more active and less cautious in areas where predators lurk. But then, in a simple, elegant experiment, she and her colleagues demonstrated that the parasite did something much more remarkable. They treated one corner of each rat’s enclosure with the animal’s own odor, a second with water, a third with cat urine, and the last corner with the urine of a rabbit, a creature that does not prey on rodents. “We thought the parasite might reduce the rats’ aversion to cat odor,” she told me. “Not only did it do that, but it actually increased their attraction. They spent more time in the cat-treated areas.” She and other scientists repeated the experiment with the urine of dogs and minks, which also prey on rodents. The effect was so specific to cat urine, she says, that “we call it ‘fatal feline attraction.’”

She began tagging the parasite with fluorescent markers and tracking its progress in the rats’ bodies. Given the surgically precise way the microbe alters behavior, Webster anticipated that it would end up in localized regions of the brain. But the results defied expectations. “We were quite surprised to find the cysts—the parasite’s dormant form—all over the brain in what otherwise appeared to be a happy, healthy rat,” she says. Nonetheless, the cysts were most abundant in a part of the brain that deals with pleasure (in human terms, we’re talking sex, drugs, and rock and roll) and in another area that’s involved in fear and anxiety (post-traumatic stress disorder affects this region of the brain). Perhaps, she thought, *T. gondii* uses a scattershot approach, disseminating cysts far and wide, enabling a few of them to zero in on the right targets.

To gain more clarity on the matter, she sought the aid of the parasitologist Glenn McConkey, whose team at the University of Leeds was probing the protozoan’s genome for signs of what it might be doing. The approach brought to light a striking talent of the parasite: it has two genes that allow it to crank up production of the neurotransmitter dopamine in the host brain. “We never cease to be amazed by the sophistication of these parasites,” Webster says.

Their findings, reported last summer, created immediate buzz. Dopamine is a critical signaling molecule involved in fear, pleasure, and attention. Furthermore, the neurotransmitter is known to be jacked up in people with schizophrenia—another one of those strange observations about the disease, like its tendency to erode gray matter, that have long puzzled medical researchers. Antipsychotic medicine designed to quell schizophrenic delusions apparently blocks the action of dopamine, which had suggested to Webster that what it might really be doing is thwarting the parasite. Scientists had already shown that adding the medicine to a petri dish where *T. gondii* is happily dividing will stunt the organism’s growth. So Webster decided to feed the antipsychotic drug to newly infected rats to see how they reacted. Lo and behold, they didn’t develop fatal feline attraction. Suddenly, attributing behavioral changes to the microbe seemed much more plausible.

As the scientific community digested the British team’s dopamine discoveries, Robert Sapolsky’s lab at Stanford announced still more attention-grabbing news. The neuroscientist and his colleagues found that *T. gondii* disconnects fear circuits in the brain, which might help to explain why infected rats lose their aversion to cat odor. Just as startling, reports Sapolsky, the parasite simultaneously is “able to hijack some of the circuitry related to sexual arousal” in the male rat—probably, he theorizes, by

boosting dopamine levels in the reward-processing part of the brain. So when the animal catches a whiff of cat scent, the fear center fails to fully light up, as it would in a normal rat, and instead the area governing sexual pleasure begins to glow. "In other words," he says, "*Toxo* makes cat odor smell sexy to male rats."

The neurobiologist Ajai Vyas, after working with Sapolsky on this study as a postdoctoral student, decided to inspect infected rats' testicles for signs of cysts. Sure enough, he found them there—as well as in the animals' semen. And when the rat copulates, Vyas discovered, the protozoan moves into the female's womb, typically infecting 60 percent of her pups, before traveling on up to her own brain—creating still more vehicles for ferrying the parasite back into the belly of a cat.

Could *T. gondii* be a sexually transmitted disease in humans too? "That's what we hope to find out," says Vyas, who now works at Nanyang Technological University, in Singapore. The researchers also discovered that infected male rats suddenly become much more attractive to females. "It's a very strong effect," says Vyas. "Seventy-five percent of the females would rather spend time with the infected male."

After I return from Prague, Flegr informs me that he's just had a paper accepted for publication that, he claims, "proves fatal feline attraction in humans." By that he means that infected men like the smell of cat pee—or at least they rank its scent much more favorably than uninfected men do. Displaying the characteristic sex differences that define many *Toxo* traits, infected women have the reverse response, ranking the scent even more offensive than do women free of the parasite. The sniff test was done blind and also included urine collected from a dog, horse, hyena, and tiger. Infection did not affect how subjects rated these other samples.

"Is it possible cat urine may be an aphrodisiac for infected men?," I ask. "Yes. It's possible. Why not?" says Flegr. I think he's smiling at the other end of the phone line, but I'm not sure, which leaves me wondering whether I've stumbled onto a topic ripe for a *Saturday Night Live* skit, or a matter worthy of medical concern. When I ask Sapolsky about Flegr's most recent research, he says the effects Flegr is reporting "are incredibly cool. However, I'm not too worried, in that the effects on humans are not gigantic. If you want to reduce serious car accidents, and you had to choose between curing people of *Toxo* infections versus getting people not to drive drunk or while texting, go for the latter in terms of impact."

In fact, Sapolsky thinks that *Toxo*'s inventiveness might even offer us some benefits. If we can figure out how the parasite makes animals less fearful, he says, it might give us insights into how to devise treatments for people plagued by social-anxiety disorder, phobias, PTSD, and the like. "But frankly," he adds, "this mostly falls into the 'Get a load of this, can you *believe* what nature has come up with?' category."

Webster is more circumspect, if not downright troubled. "I don't want to cause any panic," she tells me. "In the vast majority of people, there will be no ill effects, and those who are affected will mostly demonstrate subtle shifts of behavior. But in a small number of cases, [*Toxo* infection] may be linked to schizophrenia and other disturbances associated with altered dopamine levels—for example, obsessive-compulsive disorder, attention-deficit hyperactivity disorder, and mood disorders. The rat may live two or three years, while humans can be infected for many decades, which is why we may be seeing these severe side effects in people. We should be cautious of dismissing such a prevalent parasite."

The psychiatrist E. Fuller Torrey agrees—though he came to this viewpoint from a completely different angle than either Webster or Flegr. His opinion stems from decades of research into the root causes of schizophrenia. "Textbooks today still make silly statements that schizophrenia has always been around, it's about the same incidence all over the world, and it's existed since time immemorial," he says. "The

epidemiology literature contradicts that completely." In fact, he says, schizophrenia did not rise in prevalence until the latter half of the 18th century, when for the first time people in Paris and London started keeping cats as pets. The so-called cat craze began among "poets and left-wing avant-garde Greenwich Village types," says Torrey, but the trend spread rapidly—and coinciding with that development, the incidence of schizophrenia soared.

Since the 1950s, he notes, about 70 epidemiology studies have explored a link between schizophrenia and *T. gondii*. When he and his colleague Robert Yolken, a neurovirologist at Johns Hopkins University, surveyed a subset of these papers that met rigorous scientific standards, their conclusion complemented the Prague group's discovery that schizophrenic patients with *Toxo* are missing gray matter in their brains. Torrey and Yolken found that the mental illness is two to three times as common in people who have the parasite as in controls from the same region.

Human-genome studies, both scientists believe, are also in keeping with that finding—and might explain why schizophrenia runs in families. The most replicated result from that line of investigation, they say, suggests that the genes most commonly associated with schizophrenia relate to the immune system and how it reacts to infectious agents. So in many cases where the disease appears to be hereditary, they theorize, what may in fact be passed down is an aberrant or deficient immune response to invaders like *T. gondii*.

Epstein-Barr virus, mumps, rubella, and other infectious agents, they point out, have also been linked to schizophrenia—and there are probably more as yet unidentified triggers, including many that have nothing to do with pathogens. But for now, they say, *Toxo* remains the strongest environmental factor implicated in the disorder. "If I had to guess," says Torrey, "I'd say 75 percent of cases of schizophrenia are associated with infectious agents, and *Toxo* would be involved in a significant subset of those."

Just as worrisome, says Torrey, the parasite may also increase the risk of suicide. In a 2011 study of 20 European countries, the national suicide rate among women increased in direct proportion to the prevalence of the latent Toxo infection in each nation's female population. According to Teodor Postolache, a psychiatrist and the director of the Mood and Anxiety Program at the University of Maryland School of Medicine, a flurry of other studies, several conducted by his own team, offers further support of *T. gondii*'s link to higher rates of suicidal behavior. These include investigations of general populations as well as groups made up of patients with bipolar disorder, severe depression, and schizophrenia, and in places as diverse as Turkey, Germany, and the Baltimore/Washington area. Exactly how the parasite may push vulnerable people over the edge is yet to be determined. Postolache theorizes that what disrupts mood and the ability to control violent impulses may not be the organism per se, but rather neurochemical changes associated with the body's immune response to it. "As far-fetched as these ideas may sound," says Postolache, "the American Foundation for Suicide Prevention was willing to put money behind this research."

GIVEN ALL THE nasty science swirling around this parasite, is it time for cat lovers to switch their allegiance to other animals?

Even Flegr would advise against that. Indoor cats pose no threat, he says, because they don't carry the parasite. As for outdoor cats, they shed the parasite for only three weeks of their life, typically when they're young and have just begun hunting. During that brief period, Flegr simply recommends taking care to keep kitchen counters and tables wiped clean. (He practices what he preaches: he and his wife have two school-age children, and two outdoor cats that have free roam of their home.) Much more important for preventing exposure, he says, is to scrub vegetables thoroughly and avoid drinking water that has not been properly purified, especially in the developing world, where infection rates can reach 95 percent in some places. Also, he advises eating meat on the well-done side—or, if that's not to your taste, freezing it before cooking, to kill the cysts.

As concerns about the latent infection mount, however, experts have begun thinking about more-aggressive steps to counter the parasite's spread. Inoculating cats or livestock against *T. gondii* might be one way to interrupt its life cycle, offers Johns Hopkins' Robert Yolken. Moving beyond prevention to treatment is a taller order. Once the parasite becomes deeply ensconced in brain cells, routing it out of the body is virtually impossible: the thick-walled cysts are impregnable to antibiotics. Because *T. gondii* and the malaria protozoan are related, however, Yolken and other researchers are looking among antimalarial agents for more-effective drugs to attack the cysts. But for now, medicine has no therapy to offer people who want to rid themselves of the latent infection; and until solid proof exists that *Toxo* is as dangerous as some scientists now fear, pharmaceutical companies don't have much incentive to develop anti-Toxo drugs.

Yolken hopes that will change. "To explain where we are in *Toxo* research today," he says, "the analogy I always give is the ulcer bacteria. We first needed to find ways of treating the organism and showing that the disease went away when you did that. We will have to show that when we very effectively treat *Toxoplasma*, some portion of psychiatric illness goes away."

But *T. gondii* is just one of an untold number of infectious agents that prey on us. And if the rest of the animal kingdom is anything to go by, says Colorado State University's Janice Moore, plenty of them may be capable of tinkering with our minds. For example, she and Chris Reiber, a biomedical anthropologist at Binghamton University, in New York, strongly suspected that the flu virus might boost our desire to socialize. Why? Because it spreads through close physical contact, often before symptoms emerge—meaning that it must find a new host quickly. To explore this hunch, Moore and Reiber tracked 36 subjects who received a flu vaccine, reasoning that it contains many of the same chemical components as the live virus and would thus cause the subjects' immune systems to react as if they'd encountered the real pathogen.

The difference in the subjects' behavior before and after vaccination was pronounced: the flu shot had the effect of nearly doubling the number of people with whom the participants came in close contact during the brief window when the live virus was maximally contagious. "People who had very limited or simple social lives were suddenly deciding that they needed to go out to bars or parties, or invite a bunch of people over," says Reiber. "This happened with lots of our subjects. It wasn't just one or two outliers."

Reiber has her eye trained on other human pathogens that she thinks may well be playing similar games, if only science could prove it. For example, she says, many people at the end stages of AIDS and syphilis express an intense craving for sex. So, too, do individuals at the beginning of a herpes outbreak. These may just be anecdotal accounts, she concedes, but based on her own findings, she wouldn't be surprised if these urges come from the pathogen making known its will to survive.

"We've found all kinds of excuses for why we do the things we do," observes Moore. "'My genes made me do it.' 'My parents are to blame.' I'm afraid we may have reached the point where parasites may have to be added to the laundry list of excuses."

She has a point. In fact, I've been wondering whether *T. gondii* might in some small way be contributing to my extreme extroversion—why I can't resist striking up conversations everywhere I go, even when I'm short of time or with strangers I'll never see again. Then it occurs to me that cysts in my brain might be behind my seesaw moods or even my splurges on expensive clothes. Maybe, I think with mounting conviction, the real me would have displayed better self-control, had I not been forced to swim upstream against the will of an insidious parasite. With my feline pal Pixie on my lap (for the record, she's an outdoor cat), I call to get the results of my *Toxo* test. Negative. I don't have the latent infection.

I call to tell Flegr the good news. Even though I'm relieved, I know my voice sounds flat. "It's strange to

admit," I say, "but I think I'm a little disappointed." He laughs. "People who have cats often feel that way, because they think the parasite explains why they behave this way or that," he says. "But," I protest, "you thought the same way." Then it hits me. I may have dodged *T. gondii*, but given our knack for fooling ourselves—plus all those parasites out there that may also be playing tricks on our minds—can anyone really know who's running the show?

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