

MALICIOUS LITTLE MANIPULATORS

What can parasites do? According to Kathleen McAuliffe's book *This is Your Brain on Parasites*, they can affect human thinking and behavior, and thus change us into obedient machines.

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We like to boast of our human capacity for logical thinking, conscious decision-making and building a rational image of the world. And yet it turns out that our brains can be affected by tiny creatures invisible to the naked eye: parasites, and the dozens of pathogens carried by them, including bacteria, rickettsia and viruses. And although it is extremely difficult to believe, they can sometimes cause us to do unreasonable things, or

things that may seem unreasonable to us on closer examination. What makes parasites so powerful? How are they able to change the behaviors of the proud *Homo sapiens*?

Kathleen McAuliffe, the author of *This is Your Brain on Parasites*, does not talk about parasites per se. There are numerous textbooks on parasitology, and most of the basic information can be found in reliable online sources. The relationship between parasites and their hosts, however, which in our opinion is a far more interesting topic, has not been written about as broadly. Parasites can sometimes turn their hosts into puppets, using them to serve their own numerous needs. In fact, some of the stories McAuliffe writes about sound more like crime stories than popular science.

Piecing together the classical, zoological description of parasites was a necessary stage of research,



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but over time it ceased to provide ground-breaking information about how they actually function in the bodies of their hosts. It wasn't until molecular methods were examined that it was possible to provide a more detailed description of the functioning of parasites and their relationships with their hosts. This, in turn, touched off a flurry of scientific theories – which have largely remained only theories, because for ethical reasons some theories cannot be tested. For example, how could we test whether a small parasite infection could turn a human body into something resembling a zombie.

We do know, however, that tapeworms can modify the behavior of crickets, snails or sheep. They can disrupt their sense of danger, reduce anxiety and the need to escape. In addition, infected animals, deprived of fear, eagerly approach predators and practically give themselves up on a plate. This brings the life cycle of the parasite full circle, because the adult parasite will grow inside a predatory bird or wolf, and their droppings will include the parasite's eggs and larvae ready to infect the next host.

What parasites do to snails or sheep may be interesting, but it does not really concern humans. However, it becomes more important when we realize that parasites' manipulative capabilities can affect the behaviors of bees or spiders, which may pose a threat to humans.

Parasites recently made a splash in the glossy lifestyle magazines – but not because they are the cause of large-scale mortality in Africa or Asia, or cause problems among kindergartens. Rather, because par-

asites have come to be used in a not very responsible way to lose weight. Almost everyone has heard about tapeworms. Some people swallow their eggs on purpose, allowing the parasites to grow in their intestines to absorb excess calories and help the “patient” lose weight. Here we can also talk about parasites manipulating the host's intelligence, but in this case it happens before the infection. Many food-borne parasites can change the functioning of our digestive tract. The consequences of this are not necessarily related to weight loss. The effect can be quite opposite, and by changing the microbiome and the intestinal villi it can lead to obesity.

But the most spectacular effects are caused by the protozoan *Toxoplasma gondii*. Toxoplasmosis is probably the most famous zoonotic disease. It is all due to cats who are the ultimate host of the parasite, and their droppings are a source of infection for humans and other animals. It has long been known that this protozoan is dangerous for pregnant women. It has also been known for some time that its effects are much broader. In particular, it affects human behavior, from the way we drive, through how we choose our friends, to suicidal thoughts and risky sexual behavior. Some of these results are highly controversial, and the parasite for a while became famous thanks to the Ig Nobel Prize. However, correlation analyses, and above all well-designed experiments and population studies, indicate that *Toxoplasma gondii* do in fact manipulate human behaviors. Perhaps this is why many people react adversely to rodents, especially rats or mice. Our aversion to ugliness, dirt and certain animals can be explained by an unconscious fear of the diseases they carry.

As is commonly known, the Universe is always striving for balance, and even the distribution of parasites seems to confirm this fact. In the tropics, we can enjoy the sun and lush vegetation throughout the year, but their charm is spoiled by the numerous parasites lurking there. Dirty water, animal droppings all around, and poverty are breeding grounds for infection. Even the recently tested national level of happiness and the index of economic freedom are negatively correlated with parasitic infestations. Whether this is a causal link, or just a coincidence, will probably be determined by future experiments.

We know that when traveling to tropical areas we must ensure ourselves access to clean water and drink a gin and tonic after a meal. First-world citizens seem to think that the plague, cholera or malaria are diseases of the past, but in fact the real fight against these pathogens is just beginning.

Taenia solium
– the pork tapeworm,
belonging to the
cyclophyllid cestodes in the
family Taeniidae, is a very
long intestinal parasite.

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SUGGESTED READING

Climate change, and above all habitat transformation on a large scale, are destroying the dependency networks between many species of plants and animals. For many dangerous parasites, this is good news. Although some highly specialized parasites will die out along with their hosts, the less selective ones will find their hosts more easily in simplified ecosystems. In addition, often their hosts in such transformed environments live close together, in herds, and often have low genetic variability due to artificial treatments. This is what is happening in fields and pastures, among crops and livestock. Only one step separates them from humans, a step easily crossed by parasites.

However, parasites do not always harm their hosts – a fact which, unfortunately, McAuliffe mentions only briefly. We have learned how to use parasites for our own needs, from heparin-producing leeches, through parasites that help fight crop pests, to the previously mentioned digestive tract parasites. It is also worth mentioning that the increase in the diversity of parasites, or the presence of many different species in the environment, positively affects endangered amphibians, for example. The principle of “my enemy’s enemy is my friend” is applied here. Parasites shape their host’s immune system to their own advantage. According to Weinstock’s theory, which is still being widely tested, the increasing incidence of autoimmune diseases is associated with the lack of parasites in our bodies.

This is due to the fact that the human immune system has evolved in the presence of parasites that were a permanent fixture of our microbiome. Modern hygiene and medicine made them all but disappear, which may cause our immune system to turn against us and start attacking its own cells, resulting in an allergic reaction. Another theory says that some food al-

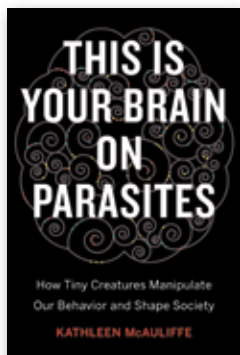
lergies are a defensive reaction of the body to proteins similar to parasite proteins. These are all speculations at the moment, because the mechanisms associated with the immunomodulatory properties of parasites are still poorly understood.

Nevertheless, nematode larvae have been used for several years now to treat such serious autoimmune diseases as Crohn’s disease or celiac disease. Some studies have even noted that many patients decide to leave the parasites inside their bodies after the clinical experiment is over. Not without reason, the intestines are called our “second brain”, and for many people even a slight stomach pain is more severe than a sore throat or headache. Or maybe it all results from changes in the brain area responsible for decision-making?

This is Your Brain on Parasites is a humorous and at the same time terrifying read. It contains many facts, explained with humor, and well-written, often horrific stories. After reading it, one can say: “Show me your parasites, and I will tell you who you are.” Our knowledge of these animals is constantly expanding. To protect ourselves against infection we must be cautious, especially when traveling, have a healthy immune system and a lot of good luck – which, as well all know, tends to come to those who are cautious and well prepared.

Next time you are on a tram, at the hairdresser or engaging in play, observe the behavior of others. Maybe some of them are being controlled by a parasite? We must be careful to not let our search for parasites become an obsession, although life without them could be even worse.

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