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Fellow Travelers

The Nonhuman Things That Make Us Human

For some years now I've had a growing sense that we are on the cusp of big changes in history and the humanities – an intellectual sense, of course, but also something that you might call a gut feeling. But I had not expected that new research on our guts would actually give those changes a push forward. Back in 2007, the National Institutes of Health (NIH) began a major five-year Human Microbiome Project that provided \$153 million in funds to scores of scientists and institutions in a coordinated effort to identify and describe the microorganisms that live on and in the human body, many of them in our digestive tracts. Five years later, the early research results were in and papers began to appear in top scientific journals. One was *Nature*, which featured the topic on its June 14, 2012, cover with the intriguing headline “Fellow Travelers.”¹ In the subsequent flurry of press attention to all the many surprising new insights into this human “microbiome,” one idea especially captured the public imagination: nearly 90 percent of the cells in your body are not yours at all but belong instead to a genetically diverse population of trillions of bacteria, viruses, and other microbes, a majority of them inside your gut, but others living on your skin, in your mouth, and even in your lungs.² “We are,” the director of the NIH concluded, “more microbial than human.”³

¹ *Nature* 486 (June 24, 2014): cover.

² Julia Adeney Thomas, “History and Biology in the Anthropocene: Problems of Scale, Problems of Value,” *American Historical Review* 119 (2014): 1587–607, here 1593 and fn. 20. A good popular account of the significance of the microbiome is Michael Pollan, “Some of My Best Friends Are Germs,” *New York Times Magazine*, May 15, 2013.

³ Peter Andrey Smith, “Can the Bacteria in Your Gut Explain Your Mood?” *New York Times*, June 23, 2015.

It later became apparent that this 90 percent figure, though still widely cited to this day, was almost certainly inaccurate.⁴ Arriving at definitive numbers on these counts is hardly the most pressing of research topics for microbiologists today, so it is perhaps no surprise that the estimates of both the number of microbes in a typical microbiome and the number of cells in a typical human body range by orders of magnitude: from 30 to 400 trillion microbes and from 5 to 724 trillion human cells. Depending on which estimates you favor, researchers suggest that our microbes might be roughly as numerous as our body cells, or, on the other extreme, they might outnumber human cells by as much as a *hundred* to one.⁵ Part of the confusion stems from whether viruses are included in the microbiome count rather than just bacteria. In a 2013 report by the American Academy of Microbiology, the authors suggested a reasonable estimate is that an average human body has about three times more *bacterial* cells than human ones. But viruses may outnumber bacteria by as much as five to one, so counting them would push the ratio of nonhuman microorganisms up much higher. Whatever the exact numbers may turn out to be, we should also keep in mind that those tiny bacteria are typically about a tenth the size of an average human cell and viruses (simple little packages of DNA which are unable to replicate on their own) are even tinier, so the microbiome of an average adult only weighs about 1.1 kilograms (2.5 pounds). By mass, our human cells definitely dominate. These caveats aside, the human microbiome is clearly immense and immensely diverse: most likely more than 100 trillion cells from over a thousand different species.⁶ Humans have about 23,000 unique genes. Our community of microbes has more than two million.

These “fellow travelers” are also doing far more than just hitching a comfortable ride. As one microbiologist notes, “The most important thing is that much of what makes us human – many of [the] important aspects of health and the predisposition to disease and recovery – depends on metabolic activity of these microbes.”⁷ Some researchers even argue that we need to rethink our conventional concept of the unitary individual

⁴ Judah L. Rosner, “Ten Times More Microbial Cells than Body Cells in Humans?” *Microbe Magazine*, February 2014.

⁵ Peter Andrey Smith, “Is Your Body Mostly Microbes? Actually, We Have No Idea,” *Boston Globe*, September 14, 2014.

⁶ Ann Reid and Shannon Greene, *Human Microbiome: A Report from the American Academy of Microbiology* (Washington, DC: American Academy of Microbiology, 2013): 6.

⁷ Quoted in Smith, “Is Your Body Mostly Microbes?”

human, suggesting that the human organism might be better thought of as analogous to a coral reef, an “assemblage of life-forms living together.”⁸ Some of these microbes play a pivotal role in sustaining human life, particularly in our digestive system where they help to break down foods that would otherwise be indigestible and to synthesize many of the chemical compounds essential to human metabolism. Even more striking, recent collaborations between microbiologists and neuropsychologists have created a growing body of evidence that these tiny fellow travelers may exert a powerful influence over our brains by producing so-called psychobiotics, hormones, and other chemicals that can affect whether we feel optimistic or pessimistic, bold or timid, energetic or lethargic.⁹ The microbiome typically manufactures some 95 percent of our body’s supply of serotonin, a neurochemical that powerfully influences our brains – hence the utility of the widely used anti-depressant drugs known as serotonin reuptake inhibitors. Some researchers suggest that we have a sort of second brain in our guts that is as much microbial as human.¹⁰ One of the pioneers of these psychobiotic studies has even found compelling evidence (albeit in nonhumans) that “if you transfer the microbiota from one animal to another, you can transfer behavior.”¹¹

Now it is hardly big news that various chemicals can change the way the human brain works, and hence our personalities and behaviors – a sizable number of us deliberately and regularly consume substances that do just that. What is really intriguing about these microbiobiochemical factories in our guts is that these are not external chemicals, like alcohol or caffeine, that we can choose to ingest or not. Rather, these psychoactive chemicals are the products of billions of nonhuman organisms that began colonizing our guts on the day we were born entirely for their own purposes. By the time you are an adult, almost three pounds of your

⁸ Quoted in Thomas, “History and Biology in the Anthropocene,” 1594.

⁹ Timothy G. Dinan, Catherine Stanton, and John F. Cryan, “Psychobiotics: A Novel Class of Psychotropics,” *Biological Psychiatry* 74 (2013): 720–26.

¹⁰ Siri Carpenter, “That Gut Feeling,” *American Psychological Association* 43, no. 8 (September 2012): 50.

¹¹ Quoted in Smith, “Can the Bacteria in Your Gut Explain Your Mood?” A seminal early paper was Mark Lyte, Jeffrey J. Varcoe, and Michael T. Bailey, “Anxiogenic Effect of Subclinical Bacterial Infection in Mice in the Absence of Over Immune Activation,” *Physiology and Behavior* 65 (1998): 63–8. See also Elaine Y. Hsiao et al., “Microbiota Modulate Behavioral and Physiological Abnormalities Associated with Neurodevelopmental Disorders,” *Cell* 155 (2013): 1451–63, and Javier A. Bravo et al., “Ingestion of *Lactobacillus* Strain Regulates Emotional Behavior and Central GABA Receptor Expression in a Mouse via the Vagus Nerve,” *Proceedings of the National Academy of Sciences* 108 (2011): 16050–5.

body is not “you” at all, but this mass of bacteria, and our relationship seems more commensal than domesticated. These bacterial fellow travelers can also evolve much more rapidly than can their less genetically nimble human hosts. As one researcher puts it: “The bacteria in our guts are continually reading the environment and responding [in ways that] help our bodies respond to changes in our environment.”¹² Given all this new evidence, it seems fair to say that there is within each of us a biologically creative population of organisms that not only help to keep us alive – or, at times, threaten to harm or kill us – but also play a significant role in making us who we are. We are always a “we,” even when we are alone.

As a historian, and a neo-materialist environmental historian at that, I was immediately intrigued by what these new scientific insights might mean for our understanding of history and the broader humanities. But a good measure of caution is warranted. The science of the microbiome is in its infancy. Much of the work on psychobiotics has been done with mice or other nonhuman animals, and the same is the case with other recent studies suggesting the microbiome might play a role in human problems like autism and depression.¹³ I might identify as “mammal,”¹⁴ but I know better than to think that all my furry endothermic cousins share every aspect of my biochemical metabolism. At this early point it might be a bit premature to apply these insights to our study of the past, except perhaps, as some historians have suggested, in collaboration with microbiologists using historical evidence to study the topic.¹⁵ Still, if these early results are confirmed and extended, eventually the microbiome could easily fit in with the recent spate of historical studies examining the influence of alcohol, caffeine, DES, and other chemical and environmental factors on past humans. The potential questions are endlessly fascinating. How might the shift in affluent societies in the nineteenth century to the regular consumption of unprecedented amounts of beef and sugar have influenced gut microbiomes and human moods and actions? Likewise, it is well known that the aggressive use of broad-spectrum antibiotics in the post-war period was akin to carpet-bombing our microbiomes. How might this

¹² Quoted in Pollan, “Some of My Best Friends Are Germs.”

¹³ Carpenter, “That Gut Feeling,” 50, and Sara Reardon, “Bacterium Can Reverse Autism-like Behaviour in Mice,” *Nature News* (December 5, 2013).

¹⁴ Randy Laist, “Why I Identify as Mammal,” *New York Times*, October 24, 2015.

¹⁵ “Introduction: History Meets Biology – AHR Roundtable,” *American Historical Review* (2014): 1492–9, here 1496.

have influenced the way people felt, thought, and acted during this period of history?¹⁶

But even if the day of “microbiomic history” is perhaps not yet quite upon us, I begin with this brief discussion of the new science of the microbiome because it offers such a (literally) visceral example of a much-broader point: we live in a time when our basic understanding of what it means to be “human” is radically changing. Insights from across the spectrum of both the sciences and the humanities are telling us that the human body, mind, and culture are even more deeply embedded in our biological and material environments than we could have previously imagined. Let me quickly highlight here a few more examples that I will deal with in more detail later in the book:

- **Epigenetics:** When I was in college in the 1980s, I was taught that, other than mutations caused by radiation or other relatively rare and random mutagenic factors, the genome preserved in my DNA is impervious to most environmental influences during my lifetime. There was no greater sin in evolutionary biology than Lamarckianism: no matter how accomplished I become at Ping-Pong, I was not supposed to be able to pass on my hard-won skills to my offspring. But now epigenetic theory tells us that environmental factors (if perhaps not rigorous Ping-Pong training) can actually turn parts of our genetic code off and on in ways that affect the physiology and behaviors of living organisms in “real time.” Commenting on a recent study that suggested the distinct behaviors of ants in different castes could be changed through epigenetically mediated environmental factors, one geneticist observed that we are now beginning to understand “how the environment gets under the skin to affect gene expression, and consequently, neural activity and behavior.”¹⁷ More controversially, a growing body of evidence suggests that at least some of these epigenetic changes might in a limited sense be heritable over several generations – a sort of “inheritance of acquired traits” that had once been thought entirely impossible.

¹⁶ See, for example, Martin J. Blaser, *Missing Microbes: How the Overuse of Antibiotics Is Fueling Our Modern Plagues* (New York: Henry Holt, 2014).

¹⁷ Quoted in Elizabeth Pennisi, “Bipolar Drug Turns Foraging Ants into Scouts,” *Science Magazine*, December 31, 2015. The original article is Daniel F. Simola et al., “Epigenetic (Re)programming of Caste-Specific Behavior in the Ant *Camponotus floridanus*,” *Science* 351 (January 2016).

- **The Extended Evolutionary Synthesis:** Some evolutionary biologists are now calling for an “extended evolutionary synthesis” that would expand beyond a “gene-centric” understanding of evolution to better recognize the way in which highly plastic organisms develop in response to an environment they themselves alter, what they refer to as niches. Living things do not simply evolve to fit into preexisting environments, they argue, but co-construct and coevolve with their environments. Along with this concept of niche construction, the extended evolutionary synthesis stresses the plasticity of organismal development that allows, for example, the color of butterflies or the shape of leaves on a tree to change depending on environmental factors – not just over the course of generations of evolution, but during the developmental lifetime of a single organism.¹⁸
- **The Extended or Embodied Mind:** On the cognitive front, many thinkers have now clearly abandoned the old Cartesian idea of a disembodied, abstract mind to argue for what they call an “embodied” or “extended” mind. How we think, they suggest, emerges in significant part from our bodily and sensory engagement with *things* in our environment. The prominent cognitive theorist Andy Clark argues that there is an “unexpected intimacy of brain, body and world,” suggesting that the mind itself “is best understood as the activity of an essentially *situated* brain: a brain at home in its proper bodily, cultural and environmental niche.”¹⁹ Another researcher in the new field of haptics – the science of human touch – also stresses how our senses embed our mind in the material world: “Haptic intelligence is human intelligence.”²⁰
- **Cognitive Linguistics:** In a forceful challenge to the once-popular post-modern emphasis on the power of discourse to construct reality, some cognitive linguists now argue that language and language-based thought must be understood in material terms, as they emerge from the way our brains have evolved to efficiently engage the environment through our sensory systems. “We use our primate perception and

¹⁸ Kevin Laland et al., “Does Evolutionary History Need a Rethink? Yes, Urgently,” *Nature* 514 (2014): 161–4, quote on 162.

¹⁹ Andy Clark, “Where Brain, Body, and World Collide,” in *Material Agency: Toward a Non-Anthropocentric Approach*, ed. Carl Knappett and Lambros Malafouris (New York: Spring, 2008), 1–18, quote on 1, emphasis in original.

²⁰ Adam Gopnik, “Feel Me: What the New Science of Touch Says about Ourselves,” *The New Yorker* (May 16, 2016): 56–66, quote on 65.

action systems,” the cognitive linguist Benjamin Bergen writes, “not only when we’re actually perceiving or acting but also when we’re understanding language about perceiving and acting.”²¹

While diverse in their disciplines, methods, and theories, all of these insights seem to point squarely toward the same basic realization: humans do not just manipulate a clearly separate and distinct material environment that exists beyond the bounds of our genes, bodies, brains, and minds. Rather, this material environment is the very stuff out of which the changing and evolving amalgam that we call human emerges. Our human fellow travelers include not just the bacteria in our guts, but countless other material things, both biotic and abiotic, that have in very concrete and specific ways helped to create who we are in all dimensions: biological, social, and cultural. Echoing the realizations sparked by our new understanding of the microbiome, the cognitive linguist George Lakoff captures the broader significance of our historic moment: “As a society,” Lakoff concludes, “we have to rethink what it fundamentally means to be human.”²²

If our understanding of what it means to be human is now undergoing such fundamental revisions, it seems evident that our idea of what we call the humanities must change as well. Indeed, these changes have already begun in some humanist disciplines, and part of the purpose of this book is to round some of these new insights up into a coherent new synthesis. My hope is that the result will be of interest to many humanists, social scientists, and other scholars, although my focus is particularly on the practical utility of this new materialism for my own discipline of history. In recent years historians have made great progress in writing a more embodied, biological, and environmental history of the past, and they have sometimes anticipated the ideas noted above. Despite this progress, a great deal remains to be done. As a more materialist and less anthropocentric understanding of the human animal begins to move toward center stage, historians should also take a leading role in both interrogating and guiding its development. Even though the research supporting a materialist understanding of humans and their histories offers powerful evidence *against* any simplistic reductionism or essentialism, history suggests there will inevitably be those who will try to misuse powerful and

²¹ Benjamin K. Bergen, *Louder Than Words: The New Science of How the Mind Makes Meaning* (New York: Basic Books, 2012), 253.

²² Quoted in Bergen, *Louder Than Words*, x.

even liberating new ideas to justify their own repressive ends. All the more reason that historians need to incorporate these new ideas into their work and provide compelling stories about the past that offer much-needed insights into the profound moral, ethical, and philosophical questions that they raise. The drumbeat of recent news reporting the imminent demise of the humanities notwithstanding, in a time of such radical change the humanistic disciplines are more essential than ever. Relatively few scientists have the inclination, time, or training to explore the broader social and cultural consequences of their insights. Yet it is equally true that humanists cannot hope to play a leading role in shaping these new ideas if they are intent only on defending an older humanism that, for all its many strengths, often reflected ideas about the human place in the world that compelling evidence now suggests were deeply mistaken. Many of these earlier mistakes derived from what was once seemed to be an entirely reasonable assumption that humans and their extraordinary cultures, cities, and technologies were largely or entirely distinct from the material world around them. Humans no longer came *from* nature, it was believed, but had instead left nature behind to henceforth shape the material world to their own end. Yet today convincing new evidence is telling us that humans are both far more embedded in material things than we had previously realized and that these things with which we are entangled are far more dynamic and creative than we had once understood. If these propositions are true, as I will argue, then we humanists need to create a less anthropocentric history of our species, one in which what we had once understood as solely “our” intelligence, creativity, culture, power, technologies, and cities are understood as emerging in significant part from a broader world of intelligent and creative animals, plants, metals, and other material things that have made us. In this book I want to explore some of the many ways in which humans are the products of an infinitely generative partnership with the things that surround us – a partnership that can be both wonderfully creative and horrifically destructive.

A few years back while my family and I were living in Munich, Germany, we became good friends with our downstairs neighbors, a couple who grew up in the then–East German city of Leipzig but had moved to Bavaria after reunification. They spoke little English (Russian having been the proper second language to learn in the old Soviet bloc), but this gave my wife and me an opportunity to improve our German during weekend *kaffeeklatsche* that became our habit. The husband had a son who would

also occasionally join us, a thoughtful young man who had just finished a year in the German army. Knowing that I was working on this book, one morning he asked me what it was about. I tried to compress the book to what I thought was its essence. It was, I said, an argument for how we can understand humans and their histories as natural – that we are what I was just then starting to call “natural-born humans.” I was a bit annoyed that, instead of finding this idea intriguing or challenging, he responded, “But, of course, it’s obvious that humans are natural!” Since humans come from nature, he argued, then everything that humans did must also be natural. Trying to explain that my meaning was a bit more complicated, I countered, “But don’t most people think that things like technology or culture are basically unnatural – that they’re entirely human inventions?” If they did, he responded, they were wrong. “Human brains evolved from nature,” he said, “so the human way of thinking is natural too.”

I started to respond, but the conversation at the table was already shifting to the more immediately engaging topic of the relative merits of different Bavarian sausages. Since then, though, I have been surprised by how frequently I encounter this same basic idea: since humans are natural, everything they do must be natural. Surely, I realized, this said something important about the meaning of “nature” today, at least in those mostly Western-influenced corners of the globe I know best. Earlier generations of thinkers found all sorts of seemingly good reasons to believe that humans were unnatural or at least clearly separate from nature: various religious faiths that viewed humans as divine creations; the manifest uniqueness of powerful human technologies; and the seemingly obvious superiority of humans over all other animals on the planet, who had been either domesticated, confined to vestigial remnants of “wilderness,” or wiped out altogether. In 1991 the sociologist of science Bruno Latour had felt such a pressing need to explain that “we have never been modern” – by which he meant, at least in part, that humans had never really left nature – he published a whole book on the subject.²³ Yet now, a mere quarter of a century later, seemingly the opposite view has become common if not dominant: it seems we are no longer “modernists,” we are all “naturalists” – even if most of us still prefer to keep our clothes on in public.

²³ Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (Cambridge, MA: Harvard University Press, 1993).

This constitutes progress of a sort. Better a simplistic naturalism than an overly dichotomist modernism. But still, the ease with which so many people had apparently decided that humans were, after all, entirely natural left me feeling suspicious. Could the grounds have really shifted that quickly? Hopefully it was not just self-servingly, but I eventually concluded my suspicions were justified and that this apparent shift to naturalism was often little more than a clever ontological sleight of hand. It offers a simple explanation of how humans came to be and why they do things differently from other animals on the planet, effectively forestalling the need for much further thought on the matter. The supposedly natural explanation is that humans evolved from earlier life forms on the planet, and as my young German friend suggested, evolution eventually gave rise to the human brain and the mind's seemingly infinite capacity for creative ideas. Now this sounds very rational and scientific, and so it is for the most part. But notice the slippery trick at the very end: nature, which up until that point had been solidly in the material realm, effortlessly jumps into the realm of abstract ideas. The brain remains material, but the abstract mind apparently has no limits. Here humans can imagine all sorts of things that do not exist in the material world around them: unicorns and flying pigs, warp drives and transporters, world peace and universal social justice, and on and on. Yet in this shift to abstracted idealism, naturalism abandons the material world and starts to seem again like the antithesis of matter. In fact, it would only take a light shove to push it right back over into the realm of supernatural creators or the divine spark of the mind, topics I will return to in the next chapter. So maybe the new naturalism is not so far from the old modernism after all: the human mind, whether it came from god or nature, still rises above materiality and even its own material matrix to become the ultimate creative force. Nature may have created humans, but oddly, once the job was done, it appears to have transferred all the *real* creativity to big-brained humans.

For the idea that we are natural-born humans to be worth anything, then, it became clear to me that it had to offer some explanation for how even the seemingly most cerebral and abstract human traits – phenomena like intelligence and creativity – are the products of bodies, brains, and minds that extend out into and constantly intermingle with the environment around us. The goal of this book is to offer just such an explanation, though obviously this modest volume can at best be only a step in that direction. But now, several years of writing and thinking later, if I had a chance to explain the topic of this book to my German friend, I would