

The Microbiome as TED Knows It: Popular Science Communication and the Neoliberal Subject

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ABSTRACT

Background Although criticized for a variety of reasons, TED platforms and conventions have been engaged, often uncritically, as tools for popular science communication. This article critically examines four TED Talks that engage the relatively recent biomedical concept of the human microbiome.

Analysis Neoliberal values underpin both the TED universe and the marketization of science. TED conventions produce a discursive regularity that brings together neoliberal subjectivity and bioeconomic imperatives of contemporary scientific research. This neoliberalization is supported by uncritically championing citizen science and the so-called democratization of science alongside crowdsourcing and crowdfunding appeals.

Conclusions and implications Uncritically embracing TED Talks can implicate science communication in the reproduction of problematic ideological positions that favour economic interests over the social good or even individual health.

Keywords Science communication; Human microbiome; TED Talks; Neoliberalization of science; Neoliberal subjectivity; Crowdfunding and crowdsourcing; Cultural studies of science

RÉSUMÉ

Contexte Les plateformes et conférences TED ont contribué à rendre la science accessible, même si elles souvent manqué de discernement en le faisant. Cet article effectue un examen critique de quatre TED Talks portant sur le concept relativement récent de microbiome humain.

Analyse Des valeurs néolibérales sous-tendent l'univers TED et la marchandisation de la science. Les conférences TED associent ordinairement une subjectivité néolibérale aux impératifs bioéconomiques de la recherche savante contemporaine. Elles appuient le néolibéralisme en vantant de manière parfois irréfléchie la prétendue démocratisation de la science, les sciences participatives, la production participative et les appels au sociofinancement.

Conclusions et implications Accepter sans réserve les TED Talks peut entraîner la communication de la science à reproduire des partis pris idéologiques problématiques, favorisant des intérêts économiques au détriment du bien commun ou même de la santé personnelle.

Mots clés Communication de la science; Microbiome humain; Conférences TED; Néolibéralisation de la science; Subjectivité néolibérale; Sociofinancement et production participative; Études culturelles sur la science

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Introduction

Post-Pasteurian reckonings and the human microbiome

It has been said that we live in a post-Pasteurian world in which long-held assumptions about our relationships with the microbial world are being challenged in fundamental ways (Paxson, 2008). One reason for this claim lies with the rise of drug-resistant bacteria in response to the overuse and misuse of antibiotics. Drug resistance is cause for considerable alarm because of what the “end of antibiotics” means for pharmaceutical intervention as a staple medical response to bacterial infections tied to many diseases, including tuberculosis, cholera, and syphilis. Concerns have also been raised about the inadvertent side effects of our adversarial relationship with microbes, as is illustrated in routine hygienic and disinfectant practices that wipe out beneficial germs alongside potential pathogens. Post-Pasteurianism is not only tied to antibiotic resistance or antimicrobial practices, however, as it is also bound to the equally concerning emergence of a pandemic culture that insistently amplifies anxieties regarding the vulnerability of our bodies and societies to contagious viral diseases such as AIDS, influenza, SARS, and Ebola (Gerlach & Hamilton, 2014; Ironstone, 2011). The post-Pasteurian microbial imaginary signals a dramatic shift in thinking about human-microbe relations away from a rigid “antisepticonsciousness” (Tomes, 2000, p. 192), with its tools, practices, and procedures developed to mitigate infections, and toward a model of multispecies symbiosis in which humans and microbes necessarily coexist, albeit precariously.

Significant to conceptualizing multispecies symbiosis has been the “discovery” of the human microbiome, an ecosystem of trillions of microorganisms or microbiota living on and in the human body. Although some of these microbes may be responsible for disease, the vast majority of microbes are not, with a great number contributing to vital human processes, such as metabolism. Research into the human microbiome has challenged long-held assumptions founded on the “germ theory of disease,” a theory that emerged at the end of the 19th century and posited a causal relationship between certain germs and disease states. If this theory was once received as a piece of fanciful speculation, even by physicians (Tomes, 2002), its gradual acceptance paved the way for a radical transformation in ways of thinking and talking about health and illness. At the centre of a biomedical paradigm shift, the germ theory also contributed to dramatic changes that were both conceptual and practical outside the laboratory, including in public health and hygiene movements, domestic practices, and everyday ways of thinking about and managing bodies. In her book *The Gospel of Germs: Men, Women, and the Microbe in American Life*, Nancy Tomes (2002) explores the introduction of the idea of the microbe into popular consciousness and makes the historical connection between what she calls “Apostles of the Germ,” scientists such as Louis Pasteur and Robert Koch who worked to legitimize the germ theory of disease, and “Entrepreneurs of the Germ,” those who capitalized on the idea in the marketplace in the form of germicides, deodorants, filters, and other products advertised to newly antiseptic-conscious and hygiene-concerned consumers. This connection between “apostles” and “entrepreneurs” is also evident in the emergence of the idea of the human microbiome today, and it is one that is central to unravelling the complex interchange between human microbiome research and its popular communication on TED platforms.

It is not surprising that the human microbiome has been featured in a number of TED talks as one of its “ideas worth spreading.” Research into the human microbiome is poised to become a key player in the biomedical paradigm shift taking place around big data, (microbial) genomics, and theranostics or diagnostic testing directed at targeted therapies that may pave the way for personalized medicine (Prainsack, 2012). This research and its application have many of the hallmarks of the technoscientific “innovation” and “entrepreneurship” that have become staples in the TED universe. Online TED talks, with their global reach and over one billion viewers, also provide an important communication platform for human microbiome research, insofar as this research requires participation from so-called “citizen scientists,” microbial genomics prosumers who will voluntarily contribute data, provide samples, and pay for their sequencing in exchange for profile information on their own resident microbiota. TED’s contribution to the discourse on the human microbiome is illustrative of interrelated shifts that have taken place with the neoliberalization of science (Cooper, 2008), including the production of identities tied to its articulation (Rose, 2007), and its championing of new structures to support the bioeconomy (Lebraty & Lobre-Lebraty, 2013), such as crowdsourcing and crowdfunding, in a period of declining governmental support for research (Byrnes, Ranganathan, Walker, & Faulkes, 2014). Bringing together a new brand of entrepreneur-scientist, who utilizes the tools of popular science communication the TED talk affords in order to pitch the promise of technoscientific innovation, with the “citizen scientist,” who responds to the call to participate in the “democratization” of science, these talks on the human microbiome interpellate audience members as subjects addressed by the neoliberal values that underpin both the TED universe and the contemporary neoliberal bioeconomy. As such, the human microbiome as TED knows it must also be understood as a socio-political intervention, a re-conceptualization of the self, the body, health, and disease with far-reaching social and political ramifications.

Four TED talks that appeared online between 2012 and 2014 are particularly illustrative of the alignment of popular science communication, the neoliberalization of science, and the production of novel conceptualizations of the self, the body, and disease in the discourse on the human microbiome. These rich examples of this alignment are, in chronological order of their appearance: biologist Jonathan Eisen’s (2012) TEDMED talk, “Meet Your Microbiome,” uBiome co-founder Jessica Richman’s (2013) TEDMED talk, “Could a Citizen Scientist Win a Nobel Prize?”, engineer, ecologist, and entrepreneur Jessica Green and cell biologist Karen Guillemin’s (2013) animated TEDEd video aimed at children, “You Are Your Microbes,” and microbial ecologist Rob Knight’s (2014) TED talk, “How Our Microbes Make Us Who We Are.” As of July 2018, these online videos have been viewed over 3.6 million times, a number that continues to rise. The videos were selected for analysis because they represent the first substantive discussions of the human microbiome available on TED or its affiliated online platforms. These online videos also reflect the discussion of the human microbiome against the backdrop of shifting sites of bioeconomic rationality and alongside the production of a subjectivity that may recognize itself in it.

This article will first discuss the history of TED, laying out a variety of critiques of the genre. It will then turn to how TED platforms and conventions are engaged as tools

for popular science communication and tie this to an overarching concern about how TED talks participate in the neoliberalization of science. Next, the article delves into a discussion of the talks by Eisen (2013), Knight (2014), and Green and Guillemin (2013) and how they use the tools of TED to engage their audience. The aim in this section is not to enumerate the rhetorical strategies of these talks, but, rather, to show how they point to a discursive regularity in which the self, self-help, and bioeconomic imperatives come together. Subsequently, Richman's (2013) talk is explored in order to address how human microbiome research encourages participation in crowdsourcing and crowdfunding for research. This article argues that the citizen scientist is at the core of the neoliberalization of science in TED talks. In conclusion, some of the implications of the uncritical embrace of TED conventions for science communication are discussed.

Neoliberal TED: Edutainment as interpellation

The brainchild of Richard Saul Wurman, TED, or "Technology, Entertainment, Design," has undergone many changes since it began in 1984 as a technology and design conference aimed primarily at "Silicon Valley entrepreneurs" (Shumar, 2016). Now "curated" by Chris Anderson, a former journalist and magazine publisher whose nonprofit, the Sapling Foundation, acquired it in 2001, TED has grown into an organization with a staff of around 140. It now hosts twice-yearly, weeklong "experiences" with over 50 talks under the banners of TED and TEDGlobal, as well as other special events, such as a TEDYouth conference and smaller TED Salons. Videos of a selection of talks were first posted online to sites such as YouTube and iTunes starting in 2006, and in 2007 TED.com, an "amplifier website," was launched to support the online publication of thousands of TED Talks. Collectively, the videos have been viewed over a billion times. TED has introduced a number of other programs beyond the conferences, including a book series (TED Books), a TED Prize of U.S.\$100,000, and, starting in 2012, a youth and education initiative to "support teachers" and "spark curiosity in students" by providing "lessons worth sharing" through a TEDEd portal (TEDEd, n.p.). The TED franchise is a large one, supplemented by its licensing of an independent annual health and medicine conference established under the banner of TEDMED, and smaller "TED-like" community-based TEDx events. "Innovation" in science and technology is also a staple for the TEDMED franchisee conference, as it claims to bridge "the gap between science and the public by finding and sharing stories that inform, inspire, engage and provoke action across a broad, passionate community both inside and outside of health and medicine" (TEDMED, n.d.).

As a tool for popular science communication, TED videos have been lauded for their ability to disseminate scientific information widely and to a non-specialist audience. TED talks are argued to construct a proximity that directly addresses and therefore engages the audience, breaking down perceived barriers to communication between scientists and the public (Scotto di Carlo, 2014). Seen as a corrective to the challenges and limitations of science communication (Burns, O'Connor, & Stocklmayer, 2003), TED and TED-style talks have been the focus of a number of studies particularly aiming to popularize science (Sugimoto, Thelwall, Larivière, Tsou, Mongeon, & Macaluso, 2013), to provide a novel, interactive format for science com-

munication (Sugimoto & Thelwall, 2013), or develop an audience that will contribute to research in the form of crowdsourcing data or crowdfunding to finance projects (Byrnes et al., 2014). The talks prioritize results rather than methods, shy away from the use of technical jargon, and “display a certain degree of informality and colloquialism in their delivery” (Caliendo, 2012, p. 110) in order to widen their appeal to a general audience. With visual supports such as images, animations, and short videos, TED talks are more accessible than formal academic talks. The talks also create a kind of “academic capital” (Sugimoto & Thelwall, 2013, p. 665) for those who deliver them because of their expanded audience. Although the “Saganization” of popular science communication remains a worry for some, particularly those in their early career (Shugart & Racaniello, 2015), studies aimed at scientists argue for the capacity of TED or TED-like talks to perform outreach and to disseminate research findings and the value of scientific research more broadly. They also praise TED as a means to encourage investment in research programs. Nonetheless, while it may be possible to argue for the value of online videos such as TED talks for popular science communication, detractors have a variety of worthy complaints, such as claims that TED talks package information as knowledge, parade simplified understandings of problems as solutions, and eschew critical engagement with the ideas being presented. On the one hand, TED talks are seen to serve both the public and science, while, on the other, they are seen to be doing both a disservice.

The TED franchise, in all its permutations and combinations, has been the focus of criticism because of its perceived elitism (Robbins, 2012) and corporatism (Jurgenson, 2012), who is selected to give the talks and who is not represented (Sugimoto et al, 2013), the kinds of ideas it highlights (Curry, 2015), how its format may manipulate audiences (Ludewig, 2017), how it frames social problems (Harouni, 2014), and for encouraging passive and uncritical audiences (Bratton, 2013; Robbins, 2012). Megan Hustad (2015) is critical of the evangelizing tone of TED talks and the manipulative potential of the “missionary zeal” (p. SR4) with which they put forth ideas, a sentiment shared by Benjamin Bratton (2013), who notoriously turned the TED genre back on itself when he called it “middlebrow megachurch entertainment” (n.p.) during his own TEDx talk entitled, “We Need to Talk about TED.” Bratton, similar to others, is concerned with the oversimplification of ideas in the standard 18-minute time allotment for each talk, and how this leads to “placebo science and medicine” and “placebo politics and placebo innovation” (Bratton, 2013, n.p.). Houman Harouni (2013) shares similar concerns, noting the homogeneity of TED talks and their style of delivery, which he says takes the form of the easily digestible and reductive “pitch,” rather than a deep reflection on ideas. Alex Pareene (2012) describes the mode of delivery as “a bit of Vegas magician-with-PowerPoint stagecraft” (n.p.). As Nathan Jurgenson (2012) has written:

At TED, ‘everyone is Steve Jobs’ and every idea is treated like an iPad. The conferences have come to resemble religious meetings and the TED talks techno-spiritual sermons, pushing an evangelical, cultish attitude toward ‘the new ideas that will change the world.’ Everything becomes ‘magical’ and ‘inspirational.’ (n.p.)

In TED talks, under the guise of the historically familiar apostle-scientist, the new character of the entrepreneur-scientist appears to inspire and persuade, certainly, but also to open ideas and the technologies tied to them to an expanded marketplace.

Chris Anderson (2016), the “Head of TED,” recently published *TED Talks: The Official TED Guide to Public Speaking*, which confirms many of the claims regarding the generic formalization of the talks made by Giuditta Caliendo (2012), Cassidy Sugimoto and Mike Thelwall (2013), Tobias Denksus and Daniel Esser (2015), and Julia Ludewig (2017). In it, Anderson (2016) lauds the “renaissance in public speaking” (p. xi) that has TED at its core, while offering up a guidebook geared to “unlocking empathy, stirring excitement, sharing knowledge and insights, and promoting a shared dream” (p. xi). A compendium of the rhetorical strategies gleaned through years of coaching TED speakers, the book outlines a kind of “presentation literacy” (p. xii). It conceptualizes every talk as containing a “gift” for its audience, a take-away that can “conjure up a compelling idea in people’s minds” and “change how people see the world” (p. 13). TED talks as conceptualized by Anderson are, therefore, intended to be more than informative; they are intended to be performative, to *do* something. At least part of what they “do” is the work of interpellating audience members into the ideological world they enthusiastically and uncritically project.

Although Anderson (2016) advises against pitching businesses or the organizations speakers represent—he says pitches by “tedious self-promoters” (p. 23) are “boring and frustrating” (p. 23)—he does acknowledge that more subtle pitches for books, organizations, or project support may appear as “nudges” in the talks. What he does not acknowledge are the ramifications of pitching ideas that both reflect and serve to unquestioningly reproduce hegemonic social, political, and economic tenets of our neoliberal moment. Anderson’s (2016) book intimates adherence to these tenets throughout, but a few examples are particularly illustrative. For example, when addressing how to “tackl[e] tough topics” (p. 41), Anderson’s advice, originating from his former colleague June Cohen, authorizes a key strategy for avoiding directly political interventions while still appealing to the entrepreneurial neoliberal subject who is the ideal addressee of TED talks. This is the strategy of *discouraging issue-based talks* that identify problems and appeal to the moral evaluations of response (or highlight a lack thereof), and *encouraging idea-based talks* that will encourage curiosity, interest, and solutions. What this means is that TED talks can be seen to steer clear of challenging problems that not only have no clear solutions but also do not, as yet, have entrepreneurs on the task of solving them. If problems only exist when there are solutions to them, even if these solutions are provisional and untried, and if solutions may only be found in a free-market of ideas pursued by entrepreneurs, then the range of possible problems to be addressed is greatly diminished.

Citing “compassion fatigue” (Anderson, 2016, p. 41) and the emotional exhaustion of audience members, Anderson identifies one of the fundamental limits of the TED talk as an educational tool addressing complex problems. As Anderson (2016) states: “It’s much easier to pull in an audience by framing the talk as an attempt to solve an intriguing riddle rather than a plea for them to care. The first feels like a gift being offered. The second feels like an ask” (p. 41). The “ask,” a direct appeal for financial sup-

port, is eschewed in the TED universe in favour of appeals that implicate audience members and encourage them see themselves as enterprising and entrepreneurial subjects in the information of the talk. These are quintessentially neoliberal subjects who respond to now-ubiquitous demands in all spheres of daily life in the Global North to be prudent, improve themselves, value self-help and its discourses (including TED's contribution to the self-help genre) as tools to do so (Blackman, 2004; Rimke, 2010), and prescribe to the intensified individualization that places responsibility squarely at their feet while increasingly asking them to reject formal dependencies on the state (McGuigan, 2014; Scharff, 2016).

TED's promise of innovation and entrepreneurial acumen is one that works to "re-enchanted us with capitalist technocracy" (Sadler, 2014, n.p.). What are touted as "revolutionary" ideas, as Mike Bulajewski once said in a Tweet cited in the literature on TED talks, only "mask capitalism as usual, giving it a narrative of progress and change" (cited in Jurgensen, 2012, n.p.). A site for re-enchantment with capitalist technocracy, the TED universe is also one in which the neoliberal narrative thrives.

In the neoliberal narrative, geniuses reinvent the world in their garages; risk takers invest in innovation; technology and trade spawns endless opportunity. It's a land without ideology; a true meritocracy where anyone with pluck and grit is sure to rise. (So long as they're really, really smart.) Above all it's an engine of prosperity, the only sure means by which to broaden and strengthen the middle class. (Curry, 2015, n.p.)

TED talks work to reinforce neoliberal values in a variety of ways, reproducing the myriad strategies through which subjects come to see themselves reflected in the information of neoliberalism. In the TED universe, neoliberalism is an unspoken organizing philosophy that permeates not only talks addressing economic issues but also talks on science, medicine, and technology.

The history of neoliberalism in practice from Margaret Thatcher and Ronald Reagan and into our present is, by now, a familiar one that traces the championing of the free market, deregulation, privatization, consumer sovereignty, and the downloading of responsibility for welfare from the state and onto individuals (Harvey, 2011). Both a political philosophy and economic policy, neoliberalism now permeates the social field in so many ways that it may now be said to shape social reality, including our perceptions of ourselves. Michel Foucault (2008) connected the neoliberal conceptualization of *homo economicus* to the production of human capital in which individuals become entrepreneurs of themselves. Governed by their own freedom and the sovereignty of choice, individuals are expected to take responsibility for themselves in a context that is increasingly competitive. Being enterprising, making the self an entrepreneur of itself, entails not only making calculated choices but also seeking out varieties of expertise in order to inform and capitalize on those choices (Rose, 2007, 2009). Innovation is not simply a characteristic of neoliberal economy but, rather, a mode by which "enterprise" is articulated in a social field that is overwhelmingly captured by the activities of commodification, including the commodification of various forms of human capital that are imagined to be inherent or biologically given (Foucault, 2008). Neoliberalism obscures and elides the inequalities that the market exacerbates, par-

ticularly the ways that “access to become an entrepreneurial subject are unevenly distributed” (Scharff, 2016, p. 109), by emphasizing ambition, calculation, accountability, and personal responsibility. Learning to manage these demands means learning to help oneself, to govern one’s own conduct.

TED talks engage the problem of self-governance by connecting audience members with speakers who are models of entrepreneurial subjectivity and with solutions to problems they might not otherwise know exist. Personal initiative is the key to getting ahead in a context where the problematization of conduct—not only what one does but also who one may imagine oneself to be—is seen as a virtue. TED talks extend the genres of self-help as a problematization of the self. Central to this project is the work of self-examination, of seeing your self through the lens of expert solutions pitched in the TED genre. These solutions not only provide suggestions for reconciling the conflicting demands on entrepreneurial subjectivity as social, psychological, and economic concerns, but TED also engages them as technoscientific and biomedical problems that demand urgent attention.

In its extension toward technoscience and biomedicine, TED and its franchisees reveal a lot about the neoliberalization of science and medicine under the auspices of “biological citizenship” (Rose & Novas, 2005). As Nikolas Rose (2007) writes in *The Politics of Life Itself*: “Attempts to educate the public about science and technology are part of the strategies for ‘making up’ the biological citizen” (p. 140). Biological citizens are encouraged to take on a relation to themselves mediated by means of the biological concepts that enable them to describe aspects of themselves and their identities. This is the individualizing force of biological citizenship that takes up scientific and biomedical knowledge of somatic individuality and applies it to the self. It is an active relation, particularly with regard to health, in which biological citizens seek out authoritative sources in health and science education, documentary media, books written by experts, and a variety of online sources, including TED talks. Biological citizenship is not only individualizing, however, as it also has a collectivizing force outside the familiar confines of national citizenship and in relation to knowledge communities. This is particularly significant in the case of human microbiome research, as will become apparent, in the establishment of the citizen scientist as a prosumer, both producer and consumer, of scientific and biomedical research. This shift appears at first glance to be antithetical to the atomizing and individualizing tendencies of neoliberalism, since it recasts the entrepreneurial subject as part of a crowd, a collective, and an interspecies multitude. However, this recasting, a recasting that works especially well in the discourse on the human microbiome, simultaneously works to fortify the individualizing and collectivizing imperatives of biological citizenship by means of remediating the neoliberal *homo economicus* as an entrepreneur of the self in the narrative of the newly “discovered” *homo microbis* (Helmreich, 2011; Sagan, 2013).

TED’s appeal to the neoliberal *homo microbis*

TED talks on the human microbiome successfully deploy rhetorical strategies such as creating a connection with the audience, telling compelling and illustrative stories, explaining difficult concepts by means of metaphors and examples, persuasion and priming, and telling by showing (Anderson, 2016). These strategies work to make what

might otherwise be technically opaque ideas accessible to a broad audience. However, they also do more. These TED talks are more than instructive; they are also performative. Entrepreneur-scientists-as-experts address neoliberal biological citizens by means of an appeal that problematizes certain common sense assumptions about who and what we are while further entrenching others. In so doing, they implicate audience members in the information, opening up investment in it as a new means of self-understanding, a new lens through which to view the self, the body, and the social. More than simply a novelty of perspective, however, this implication is also generative. It produces the *homo microbis*, the idea of the human as overwhelmingly dependent on and outnumbered by microbes, but also the biological citizen and neoliberal subject the concept of the human microbiome conjures.

The appeal to subjectivity is clear in the titles of three of the four TED talks on the microbiome that are the focus here. Eisen (2012) invites you to “Meet Your Microbes,” to conceive of *your* self and body as in communication with a “cloud of microbes” that “live in and on you.” For him, it is a question of “seeing” what is in front of us, what we, as well as medical professionals, have not taken the time to understand as central not only to our health but also to who we are. As Eisen (2012) says: “The microbial cloud, it’s right in front of us. We can’t see it most of the time. It’s invisible. They’re microbes. They’re tiny. But we can see them through their DNA, we can see them through the effects they have on people.” Indirectly perceptible by means of genetic traces and their effects on bodies and minds, microbes are, for Eisen, more than simply an outside force on which we act, sometimes with deleterious effect, as in the case of caesarian sections, antibiotics, or excessive cleanliness. They are also more than a force that acts on us, part of an ecosystem that “helps in the development of the immune system, helps in fighting off pathogens, helps in our metabolism, and determining our metabolic rate, probably determines our odor, and may even shape our behaviour in a variety of ways” (Eisen, 2012). Eisen (2012) provocatively ends his talk by stating: “We are them. They are us.” For him, the discovery of the human microbiome means coming to terms with how human-microbial relations shape biological selfhood.

In order to build his argument, Eisen (2012) frames his talk with a personal anecdote, a hallmark of the TED genre that works as a tool for connecting with the audience and providing concrete and experiential examples to illustrate core ideas. At the age of 15, he tells us, he underwent a dramatic transformation in the space of four months from a “strapping young athlete” to “basically a famine victim with an unquenchable thirst.” It was during his first-ever backpacking trip that the crisis of his transformation became apparent, as he “was putting [his] face into puddles of water and drinking like a dog.” Taken to an emergency room, he was diagnosed with ketoacidosis and type-1 diabetes, an autoimmune disease that until recently was thought to be caused by exposure to a pathogen that leads the immune system to turn against healthy cells. Eisen uses this personal story to open up his discussion of microbes, shifting attention from “microbes that do bad things,” pathogens that have been the primary focus of research, and toward microbes that “actually do us good much of the time.” The frame of his diagnosis of type-1 diabetes situates his recognition of the human microbiome concretely in the sphere of the body and identity. It also launches both his critique of traditional

medical assumptions about health and disease, embodied in his endocrinologist father's inability to "see" and therefore preemptively diagnose his son's illness before it reached a crisis, and the limitations of antimicrobial techniques in medical practice. He critiques assumptions in medical thinking and practice, and how they preclude the observation of phenomena in novel or innovative ways. A major example he discusses is the failure of conventional ileum transplantation approaches for patients with Crohn's disease, which cleared out the donor's microbes from the transplanted tissue. For Eisen, recognizing the importance of the cloud of microbes around us means challenging conventional ideas about the biological self and re-examining common antimicrobial techniques.

Rob Knight's (2014) "How Our Microbes Make Us Who We Are," as well as the TEDBook he wrote with science writer Brendan Buhler (Knight & Buhler, 2015) called *Follow Your Gut: The Enormous Impact of Tiny Microbes*, also argues for the importance of the human microbiome in "making us who we are." It also makes the case for the role of the American Gut (n.d.) project as a contributor to biomedical research on the relationship between, for example, autoimmune disorders and the human microbiome. Knight's rapid-fire talk relies less on his own personal experience with microbes, although he does contribute his own anecdotal evidence regarding mosquito bites and resident microbiota and about experimentally coating his newborn daughter with vaginal microbes because she had been delivered by caesarian section. He develops a persuasive visual argument for the necessary interrelation between humans and microbes and the effects of human interventions on microbial communities. A scatterplot showing a time-lapse of 838 days of data derived from stool samples from one of his colleague's children supports this argument. The animated scatterplot, which is the focus of the talk for over 35 seconds, shows the child's fecal data in relation to data collected from the larger Human Microbiome Project (HMP) cohort. As an example of "telling by showing," the animation visualizes the microbial development of children, a process that Knight (2014) likens to physical and mental maturation. That he does this by reference to a sample too small for scientific generalization—a sample of one—is mentioned, but only in passing. The effect of watching the child's data in movement and relationship to the HMP data of vaginal, skin, oral, and fecal results from a larger cohort is particularly profound in the last nine seconds of the animation, as Knight explains a dramatic change when antibiotics are introduced to treat an ear infection. The dot representing the child quickly jumps, moving away from the healthy state of development achieved by the child, and back to where results had appeared at birth. Although followed by "a relatively rapid recovery," the "radical change" and "setback of many months of normal development" is jarring to see (Knight, 2014). This example paves the way for a discussion on the profound effects antibiotic use conducted on gnotobiotic mice, or, in the simplified terms of the TED talk, "mice without any microbes" raised "in a germ-free bubble" (Knight, 2014).

Knight (2014) identifies a connection between human microbiome research and "how we think of ourselves," not only as identifiable by means of the traces of microbial DNA we leave on everything we touch (he humorously refers to the way the technology, which was able to identify who held a computer mouse in their palm with 95 per-

cent accuracy, was “featured on *CSI: Miami*, so you know it’s true”), but also as profoundly shaped by our microbes. He says, in reference to obesity, inflammatory bowel disease, colon cancer, and heart disease, as well as, possibly, multiple sclerosis, depression, and autism, “the three pounds of microbes you carry around with you may be more important for some health conditions than every gene in your genome” (Knight 2014). This may help support theranostic research that aims to personalize medicine, according to Knight, particularly when it comes to pharmaceutical interventions that may not be suitable for people with different microbial inhabitants.

The question of “who we are” is definitely a central stake Knight claims for human microbiome research, as it is in the TEDEd animated “lesson” “You Are Your Microbes” by Green and Guillemin (2013), which, based on its language, use of human and microbial cartoon characters, and length of only three minutes and 45 seconds, appears to be aimed at an elementary school audience. Both of the talks use spatial metaphors in order to convey key points. Knight (2014) uses spatial metaphors to convey microbial diversity, talking about how different human microbial communities in a single body are “almost like separate continents” with variations as considerable as the difference between a reef and a prairie. Green and Guillemin (2013) use spatial metaphors that illustrate population density, such as the village, the city, and the metropolitan neighbourhood, in order to suggest the vast and diverse microbial population of the body. In so doing, they also call into question the very idea of the human as unique and independent:

Being human. We each view ourselves as a unique and independent individual. But we are never alone. Millions of microscopic beings inhabit our bodies. And no two bodies are the same. Each is a different habitat for microbial communities, from the arid deserts of our skin, to the villages on our lips, and the cities in our mouths. Even every tooth is its own distinctive neighborhood. And our guts are teeming metropolises of interacting microbes. And in these bustling streets of our guts, we see a constant influx of food and every microbe has a job to do. (Green & Guillemin, 2013)

Viewers are charged with paying attention to how “our bodies are home to millions of different microbes. And we need them as much as they need us,” not only for health and well-being, but also in “shap[ing] our personal identities” (Green & Guillemin, 2013). Illustrating the digestion of food and cellulitic bacteria, respirators, fermenters, and syntropes that make energy available to the cells of the gut, the video importantly situates metabolism in terms of labour and a bodily economy.

Engaging the discussion of human microbiota in (bio)economic terms of resources and labour, Green and Guillemin (2013) simultaneously open up the pedagogy of the microbiome to its governmental possibilities, making the question of who we are into a question of “how best to manage our microbial societies.” The video problematizes food by showing how “workers” in our “microbial ecosystems” operate in the processes of digestion and the release of energy. The video illustrates that complex food molecules, such as those found in apples, require a variety of microbial workers, while simple molecules, such as the sugar in lollipops, do not. Choosing to eat simple foods is not without consequences to the microbial bodily economy: “Some of those workers are

put out of a job. Those workers leave the city, never to return” (Green & Guillemin, 2013). Bracketing the fact that the video suggests that a single lollipop will produce this result, the burden of responsibility for microbicide and the decay of the microbial city are starkly placed on the shoulders of the children who watch the video. They are charged with running the bodily economy, populating it with workers, and managing what fuel they will make available to those workers, thereby reproducing a problematic assumption that children fully control what they eat. They are additionally sidled with responsibility for the decline in microbial diversity facilitated by the indiscriminate use of antibiotics and antimicrobials, and as a potentially dangerous side effect of hygiene practices of all sorts. In the economy of the microbial city, children are often not its central agents, prudent managers, or entrepreneurial subjects who make calculated choices, but they are already being interpellated into those subject positions. In the casual slippage from questions of identity to questions of labour and economy, Green and Guillemin (2013) reveal social and cultural connections made between the discourse on the human microbiome and the reproduction of the neoliberal (bio)economy.

Crowdsourcing the future

While this discussion has thus far focused on the connections made between the human microbiome, the self, and the neoliberal *homo microbis*, it will now turn to the ways in which these connections are exploited in appeals to citizen science and the crowdfunding and crowdsourcing of microbial genomics research. Mid-way through her TEDMED Talk, “Could a Citizen Scientist Win a Nobel Prize?,” Jessica Richman (2013), co-founder of the for-profit microbial genomics company uBiome with Zachary Apt, speculates on how citizen scientists may change the future of scientific research and discovery. “[W]e have this myth in our culture,” Richman (2013) says, “that scientists are a special class of people, just like we do about artists. Scientists are somehow blessed with the ability to do science, and they’re smarter than other people, and they’re special. And maybe this is why it has taken a little while for crowdsourcing to become common in science: it is such an identity shift.” Richman’s (2013) talk calls for a “democratization” of science, a move away from a cult of scientific genius in which, she says, “a few people are anointed question askers and everyone else is not,” and toward an open system in which “the natural genius inside all of us can pour forth to help each other.” Richman’s appeal appears at first glance to be aimed at the problem of public engagement in science and the structural reasons for its failure to gain traction. On closer inspection, however, there is much more happening, particularly when one considers the promotional value the talk affords for the field of microbial genomics and the normalization of crowdsourcing and crowdfunding for both not-for-profit and for-profit scientific research. The talk can be seen as a bid to re-conceptualize the identities at play in scientific research, which operates along the lines of an entrepreneurial model in which enterprising citizen scientists contribute to “innovation.”

Richman’s (2013) talk leverages TED as a novel medium for popular science communication. She valorizes the citizen scientist and the “crowd” by means of appeals to the democratization of science and the legitimacy of the Nobel Prize. Recasting the relationship of popular audiences to the bioeconomy, Richman simultaneously implicitly enjoins them to participate in the production and consumption of biovalue.

The audience is encouraged to sign up for uBiome testing, in other words, to volunteer microbial samples, pay for their sequencing, and to permit their data to be aggregated: to be used in the analysis of other samples and deposited in a repository, sold, or exchanged for participation in larger biodata banks. Although agreements with human microbiome prosumers permit the removal of data when users revoke permission, metadata analyses already conducted and datasets already circulated will remain.

Gaining access to populations, geographic areas, or information that may otherwise be impossible for researchers to reach, public participation in human microbiome research relies on a self-selecting participatory “crowd” recruited by communication strategies that are able to translate “complex concepts into messages that can be readily digested by individuals without specific domain knowledge” (Debelius, Xu, Vázquez-Baeza, Knight, Wolfe, & McDonald, 2016, p. 47). Although for-profit and not-for-profit genomic sequencing projects must be distinguished, it is increasingly difficult to identify differences in their practices. One reason for this is that both rely on a prosumer model in which data and samples are secured in exchange for personalized results. This model relies on strategies of crowdsourcing and crowdfunding that have become a staple of scientific research (Del Salvo, 2016). Making the difference between for-profit and not-for-profit practices even murkier is the fact that the appeal to audience participation not only uses similar language but is also communicated through the same platforms, as in the case of the TED talks considered here. The distinction between Knight’s American Gut project, a university-based research project, and Richman’s uBiome, a private company, is illustrative in this regard. Both Eisen (2012) and Knight (2014) reference American Gut in their talks. Eisen is listed as an American Gut research collaborator, while Knight is its principle investigator. uBiome is a private company founded by researchers from Stanford, Oxford, and the University of California, San Francisco (uBiome, 2019a). The company’s advisory board includes Eisen. This overlap in membership is one illustration of how the lines between the two are blurred.

Another line blurred relates to research sponsorship. American Gut (n.d.) makes a clear statement about its status, saying that it is “not a company but strictly an IRB [Institutional Review Board] approved research project based in an academic institution.” However, its website also lists commercial sponsors, such as Eppendorf, a lab equipment, supplies, and services company; Second Genome, a clinical stage company; MoBio Laboratories, Inc.; and Nutraceutix, a probiotics and nutritional supplements company. uBiome is clear about its status as a private, for-profit entity, but highlights its relationship with universities and the Centres for Disease Control and Prevention (CDC). Both American Gut and uBiome blur the line between academic research project and for-profit company in a model that has become familiar as demands for the marketization of science have increased as a neoliberal imperative (Cooper, 2008; Lave, Mirowski, & Randalls, 2010; Rajan, 2007).

Both American Gut and uBiome stake a claim to “citizen science” and construct the “citizen scientist” as new kind of research subject. Much in the manner of the commercial genomics venture 23andMe and the publicly funded charitable organization UK Biobank (Tutton & Prainsack, 2011), American Gut and uBiome encourage prosumers to engage them as “promissory entities” driven by “expectations of future ben-

efits” (p. 1082) as a result of financial and personal investment. Appealing to entrepreneurial people and biological citizens for whom knowledge is important as they take responsibility for their own health by means of self-testing (Rose & Novas 2005), the concept of citizen science places participation in these sorts of research projects as a duty of citizenship and social solidarity (Tutton & Prainsack, 2011). No longer research participants or donors, citizen scientists are recruited and mobilized in research on the human microbiome through easy-to-use sampling kits that enable “citizen scientists to execute their own independent studies” (uBiome, 2019b).

Appealing to a democratization of science that enables non-specialists to participate in research, American Gut and uBiome both suggest that participation will be part of a public good that is both collective and individual. Participation involves financial support for the sequencing of one’s own data as a form of crowdfunding, the voluntary provision of samples participants will collect themselves and mail in, and metadata data gleaned through the completion of online intake, which is a means of crowdsourcing. Results and metadata then enter into anonymized circulation as they are compiled in a database, a steadily growing collection of data that enters the bioeconomy and takes on commercial value. The consequences of immaterial labour in citizen science remain underexplored (Scholz, 2013). As the stakes of crowdfunded and crowdsourced citizen science are considered, the question of who benefits from the creation of this digital biovalue must be of concern.

The limits of TED for science communication

Embracing TED or TED-style talks for science communication is, as is argued here, a double-edged sword. On the one hand, these talks have the ability to reach vast audiences and to convey scientific information in a manner accessible to non-specialist audiences. On the other hand, conventions of the genre mean that they prioritize results rather than methods, package information as knowledge, present simplified understandings as solutions to complex problems, and, arguably, produce passive audiences that lack the tools to critically engage their content. The focus on *ideas-based* rather than *issue-based* talks promotes a version of science communication that must overlook the examination of the social, cultural, political, legal, and economic contexts of the production of scientific knowledge. It also collapses the scientist-as-apostle and the entrepreneur-scientist together. By directly or indirectly pitching projects under the auspices of the idea as a “gift,” TED talks normalize an expanded domain for the entrepreneur-scientist in both privately based and public research projects.

The example of TED talks on the human microbiome illustrates how this new staple of popular science communication supports and reinforces neoliberalization, not only in science—in, for example, its conceptualization of research funding as the remit of the “crowd” and its subsequent re-articulation of the production and circulation of biovalue in the bioeconomy—but also in its endorsement of and appeal to an entrepreneurial and prudent citizen. The addressee of these talks is the citizen scientist who identifies with the value of democratizing science and is willing to invest in the possibility of future benefit out of prudence or social solidarity. The discourse on the human microbiome is an important case for the articulation of the subject of citizen science because of the paradigmatic shift it presents, not only as an explanatory model of

health and illness but also for ideas about the self.

Critically engaging TED's discourse on the human microbiome through the lens of the *issues* it raises rather than as a tool for conjuring compelling *ideas* opens up consideration of the novel tools it provides for the government of neoliberal subjects. The issues raised by human microbiome research have yet to be fully mapped out, but researchers such as Alice Hawkins and Kieran O'Doherty (2011) have questioned the social, legal, and ethical concerns that arise from the practices on which it relies, such as biobanking, including issues of privacy, discrimination, and ownership. Issues of privacy surrounding home genomics testing have already been revealed. One dramatic instance of this concerns the capture of the suspected "Garden State Killer" by means of data stored in an open source ancestry database (Wilson, 2018). The notion that breaches of privacy may lead to a lack of access to health insurance and other forms of discrimination must also be addressed. Also troubling is that results from personal microbial genomics tests may induce action by individuals who lack sufficient expertise to know how their interventions may negatively impact their health. In other words, the human microbiome is not simply an idea worth spreading, it is one that spreads in contexts that have very real social, political, economic, legal, and other consequences, and it has the capacity to yield unexpected and deleterious results.

Uncritically embracing TED talks can also implicate science communication in the reproduction of problematic ideological positions that may lend themselves to potentially unsavoury outcomes that favour economic interests over the social good or even individual health. The TED universe reinforces the neoliberalization of science in a celebration of the citizen scientist as a prosumer of new forms of biocapital (Helmreich, 2008). While posing as apolitical (Engler, 2012), the TED universe reveals much about the shaping of contemporary subjectivity in the contemporary bioeconomy, leading to a much-transformed picture of "who we are" that is itself a product of neoliberal articulations of biological citizenship. The prudent, neoliberal subject who is interpellated into TED talks on the human microbiome responds to the crowdsourcing and crowdfunding pitch that is supported by the promissory potential of the research and the appeal of participating in the democratization of science. That this democratization may only be a false promise or an unworkable ideal (citizen scientists are highly unlikely to win a Nobel Prize) is one of many reasons science communicators should pause and reflect on the implications of uncritically embracing TED.

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23andMe, <https://www.23andme.com/en-ca/>

American Gut, <http://AmericanGut.org>

Eppendorf, <https://www.eppendorf.com/worldwide/>

MoBio Laboratories, Inc., <https://mobio.com>

Nutraceutix, <http://nutraceutix.com>
 Second Genome, <https://www.secondgenome.com>
 TED, <https://www.ted.com/>
 TEDEd, <https://ed.ted.com>
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